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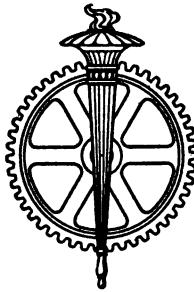


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THE  
PROPER DISTRIBUTION  
OF  
EXPENSE BURDEN

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A. HAMILTON CHURCH



NEW YORK  
THE ENGINEERING MAGAZINE  
1908

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# GENERAL

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By JOHN R. DUNLAP

WAVERLY PRESS  
BALTIMORE



## PREFACE.

The contents of this book appeared originally in THE ENGINEERING MAGAZINE as a series of articles. These at once took rank as a standard reference work on one of the most difficult questions of cost-finding; and a steady and continued demand for the numbers of the Magazine (now out of print) in which they were contained has led to the republishing of the entire group, here revised and adapted for presentation in volume form.

The accurate distribution of general expense is admittedly one of the most perplexing, but yet one of the most important, problems with which the manufacturer must deal. The simple but thorough analysis conducted in this volume, and the clear, common-sense demonstration presented, will furnish a reliable guide to the solution of highly complex conditions in factory accounting.

Much of the published literature in this field has been purely descriptive, and has gone little farther than to present specialized adaptations employed in certain individual shops, and perhaps not well suited to any but the one establishment for which each was designed. Mr. Church's material is of far greater value. He is not concerned with the



size, ruling, or printing of forms and cards—matters which should be designed by the accountant to fulfill his special purpose. He goes to the root ideas of cost-finding, and lays down broad principles by which safe and reliable figures may be obtained for machine, piece, and job costs. These principles will properly distribute all expenses of manufacture, marketing, and management, so that the truth may be known as to the profit or loss of any line of product, and changes in manufacturing cost from time to time may be instantly detected and the cause discovered. With increasing competition and increasing complexity of manufactured output this knowledge is indispensable.

THE EDITOR.

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# THE PROPER DISTRIBUTION OF EXPENSE BURDEN.

## CHAPTER I.

### INTERLOCKING GENERAL CHARGES WITH PIECE COSTS.

**W** RITING no less than sixty-eight years ago, Charles Babbage said:\* "The great competition introduced by machinery, and the application of the principle of the sub-division of labor, render it continually necessary for each producer to be on the watch, to discover improved methods by which the cost of each article can be reduced, and with this view, it is of great importance to know the precise expense of every process, as well as of the wear and tear of machinery which is due to it." And in a subsequent chapter dealing with the "causes and consequences of large factories," he points out that in reference to any particular manufacture there will be a certain minimum proportion of indirect expenditure for supervision, lighting, clerical work, passage of materials from process to process, repairing, etc., which cannot be exceeded in any similar factory without a less efficient production resulting.

\* *Economy of Manufacture*, by C. Babbage, M.A., London, Knight, 1832.

This is probably the earliest reference made by any public writer either to costs or establishment charges. Yet notwithstanding that the importance of such matters was realized by Babbage so early in the development of manufacturing industries, the lesson for various reasons fell upon deaf ears, and it is only today, when the principle of competition has attained its full growth and has become a matter of life and death, that the commercial organization of manufactories is felt to have become a matter of prime urgency.

In the present book an attempt will be made to thresh out the question of establishment expenditure and its interconnection with costs, not merely of the output as a whole, but of the piece and process in detail. To many persons who have not given sufficient attention to the matter, such a problem will present itself, in the first place as hopeless, and in the second as superfluous. Show a person of this type how he can reduce his pay roll by \$1,000 a year, and he will listen with respect. Hint to him that knowledge is power, and that absence of knowledge is weakness, and he will be alarmed, not at his own ignorance, but at the prospect of what he terms "unreproductive expenditure." A firm that will spend its money freely on plate glass and mahogany in its offices, often shrinks from the expense of getting to know what is going on in its shops.

Why is this? The true answer probably is that one is a familiar and conventional item of expenditure, and the other is "something new." One is an obvious and tangible asset, the other an easy subject of criticism for the irate shareholder who remarks "they have nothing of this kind of thing at so and so's." To spend money today for the sake of saving a much larger amount at some future period, even where the certainty is admitted, demands some moral courage; but to expend money for the purpose of raising efficiency, detecting waste, and preventing loss, demands strong judgment and confidence as well. Hence innovations in this department are made much more slowly than changes in the shops.

The difficulty of dealing adequately with establishment charges in their relation to piece and process is usually in proportion to the heterogeneity of the business carried on. In highly specialized businesses working on modern lines, it probably costs no more to maintain a close interconnection of charges and costs than to take out prime cost in any form. But in older places, where all sorts of things from steam engines to twist drills are included in one output, the difficulty is much greater, but on the other hand the need for and utility of such a connection is greater in equal degree.

At what stage in the growth of a business from very small beginnings a fully developed cost and



expenditure system becomes a necessity is difficult to say. But that it should be introduced as early as possible is desirable for reasons unconnected with its immediate use. In a small works under the personal supervision of the proprietor, who is able to give so much of his time to the affairs of the shop that he is fully conversant with the progress of work through it day by day, a cost system of any kind has but little present value. But as it is in the nature of new businesses to expand into large ones, and that sometimes with considerable rapidity, with a consequent loss of grip of detail on the part of the proprietor, it becomes very important that records shall be available representing what was accomplished in the shop at the most vigorous period of its life, namely, when the need for expansion was becoming felt.

It is not uncommon experience that expansions do not always produce the satisfactory effects anticipated. During changes of this kind something has evaporated, it is not known what, but the absence of which is recognized keenly enough in its practical effects. The real element varies, of course. It may be a less intense watch on the part of the proprietor, or it may be, with still greater probability, a dislocation of the previously existing relationship between work and the incidence of expenditure, which again may be due to a variety of causes that must needs be recognized before they are remedied.

We have not, however, to consider the case of the private proprietor alone. Probably today the larger number of new businesses are joint-stock concerns from the very commencement of their career. Innumerable companies are formed for the exploitation of some particular patent article, not infrequently under the supervision of the patentee, who presently demonstrates his unfitness for practical business management. How many vicissitudes do concerns of this type undergo, due to changes of management! Every capitalist with a taste for financing inventions can call to mind examples of this class. Every one can remember with what hopes and fears new blood has been introduced, and with what anxiety the next half-yearly or yearly balance was looked for, to lay bare the result of the change.

It is not yet recognized how immensely the task of a competent directorate, to say nothing of the advantages to a stranger coming fresh to a business to take over and reorganize its working, would be facilitated by the adoption, from the very first, of a thoroughly comprehensive method of recording shop work, including the connection of expenditure of all classes with the items of output on which they are incident. No board would think of carrying on operations without a set of commercial books arranged by an accountant in whom they had confidence; yet the equally important technical

records are nearly always treated in an amateur spirit, with the result that no two undertakings collect this information on similar lines. It is commonly left to the taste and fancy of the manager to say what records, if any, shall be kept, and how far they shall represent anything real and useful. So far is this attitude carried that many otherwise experienced business men really and conscientiously do not believe that shop accounts are of any use at all.

Yet the same men would undoubtedly give short shrift to the cashier who shirked the detailing of his petty-cash account on the ground that to keep track of small detailed expenses was not possible, or at any rate not worth doing. Nevertheless, the possible waste represented by an undetailed cash account is as nothing to the possible waste represented by an undetailed wages roll. And still more important is it to remember that, as the sum of cash expended is made up of hundreds of small items, which are and should be analyzed and classified so as to give an intelligible idea of the wisdom of the expenditure, so the productive activities in the shops are made up of innumerable small jobs, which, if properly marshalled, will tell precisely the same tale as to the wisdom of the expenditure on them as the money payments in the cash analysis.

It is true that the broad results of a half-year's

work can be read in unmistakable figures in the balance sheet. But the mischief is not only done by that time, but in the absence of proper shop accounts, it cannot be ascertained where is the element at fault. To introduce reform one must first know where reform is necessary. It is no answer to this to say that practical experience supplies the deficiency. A man with a file and a true plane surface can supply a duplicate of that plane surface if he has sufficient skill and works long enough, but he will produce the same result more quickly and surely if he has a machine tool of the highest class to aid him. And in proportion to the accuracy of the machine tool so will be the ease and speed of the performance. A modern system of organization is a high-class machine tool. It can be done without, but not economically. That is all there is to it. The wise man will make his own choice.

Thus far the argument has been directed to the desirability of a modern method of shop accounting, even though only of the class which merely records, and does not work up the results into new forms. Attention will now be directed to the particular subject of this discussion—the connection of work with the expenditure properly incident upon it. It will, of course, be readily understood that this further development implies the existence of a highly organized cost system. It cannot be worked

at all in those cases where wages are merely analyzed each week, usually by a more or less forced agreement, into the order numbers on which they have professedly been expended. Such arrangement, though admirable for the purposes of the commercial accountant, is useless for the technical accountant. And while the results required by the former are readily furnished by the operations of the latter, the converse of the proposition is a clear impossibility.

The clearest demarcation exists between direct (viz., allocable,) and indirect wages—between the wages of fitters and planers, and those of foremen, timekeepers, and messengers. But between direct and indirect *expense*, the distinction is not so obvious. Workmen's time is not without exception and at all times being employed on orders for customers or stock. Whilst it is evident that some wages never become direct expenditure on orders, all classes of wages are liable to become indirect expenditure. The same thing may be said of material. For this reason the unit selected from which all the subsequent erection is built up, is neither the wages as such nor the material as such, but the *job*.

A definition must be given of what will throughout these chapters be meant by the term "job." In this respect the distinction drawn by Mr. Slater Lewis\* between the job and the works order is

\*"The Commercial Organisation of Factories."

adhered to. The works order may, and usually does, consist of a considerable number of distinct jobs. Practically the job may be defined as the amount of time spent by any particular workman on any particular piece or similar set of pieces. Thus, a works order for a lathe will include such jobs as planing bed, cutting leading screw, milling slide rest, etc. If the works order were for six lathes of similar pattern, the jobs would be extended similarly—as, for instance, planing six beds, cutting six leading screws, etc. In the case of work done otherwise than on customers' or stock orders, the job would be for items such as new screw for No. 45 lathe, altering position of band saw No. 67, etc. It will be evident that some jobs will be charged with material and some not. Mere process work is of the latter class. Generally speaking, while the works order sets in motion the activities of all classes of labor, the job is individual to each man, his day's work being made up, it may be of one job, or it may be of several jobs.

The whole output of a shop, for any given period, consists of a number of jobs, and of nothing else. When we know all there is to be known about these jobs, we can form a very shrewd idea of the way in which things are going in that shop.

Now the elements which enter into the cost of a job are many. To ascertain merely the actual wages and material spent upon it is undoubtedly

something, but to consider these factors alone and unqualified as a basis for the comparison of the relative profitableness of work may easily lead to serious misapprehensions.

In many cases the desirability of introducing a third element into the costs becomes at an early stage obvious to the practical mind. The difference between a small cheap tool and some high-class expensive appliance seems to demand recognition in the costs of the work done on either. In seeking to remedy this, an attempt is frequently made to introduce what is termed a "machine rate" into the accounts—a charge per hour for each tool being made and debited to the job, in addition to wages and materials. This is not always an advance, however. While it is easy to see that a charge is desirable, it does not follow that the fixing of such charges is either simple or easy. Usually some arbitrary proportionate rate is made, supposed to represent the interest on capital sunk in the tool, and this reduced to a rate per hour is charged against the jobs done on that tool. The first objection to this plan is that tools are not in constant employment. But the interest, on the contrary, does not cease to run because the machine is idle. Hence this rough-and-ready settlement of the problem is deceptive and may even lead to false conclusions.

This illustration has been introduced here merely

to show, by a simple and familiar case, the general tendency of all attempts to deal with shop establishment charges. It is true that by means of the machine rate no more is usually attempted than to burden particular jobs with some of the interest on the machines concerned. But this, although, as we have said, ineffectual even for the special purpose intended, gives a very definite and clear idea of the *principle* involved, viz., the spreading of shop expenses over jobs, job by job, upon some recognized basis closely connected with the time occupied and the way of doing the work.

Even on this rudimentary plan, it is easy to see that the prime cost and the shop cost have become different things. If two jobs take three hours each, the payment for labor being the same in each case, say 20 cents per hour, we may have the respective costs of the process \$1.05 and \$1.95 respectively, if we assume machine rates of 15 cents and 45 cents in each case.

But interest is by no means the only item of indirect expense worthy of being identified with jobs. It is, in fact, one of the smaller of many items. Thus it is that prime cost is in extreme cases not even the larger half of shop cost, and in mass production may even cease to have any tangible value whatever.

Before going on to speak of shop expenses in detail and technically, something must be said of





their relation to the administrative side of the business.

Shop establishment charges are, without doubt, in many cases the "lost factor," absence of which makes the difference between success and failure in a commercial sense. There is a wide difference between technical excellence and commercial efficiency. It is not making an article that is the object to be attained, but making it *at a price*. And where various classes of things are being simultaneously made, something more accurate than practical instinct is desirable as a guide when it is required to decide which line it will pay to exploit commercially to the greatest degree. In a very small undertaking this practical instinct may be sufficient, but we are not considering the case of very small undertakings. The moment the work gets too large in volume for all its minutest details to be carried in one head, the necessity for a close analysis and interlocking of expenses with jobs becomes marked.

Nor must it be supposed that the "departmentalization" of undertakings is more than one step, though certainly a very necessary step, in the solution of this problem. To separate the expenses incurred in or in connection with the work or organization of each shop does not usually help us to any knowledge of the interior economy of that shop, if more than one class of articles are

passing through it. In the rare case that a department contains machines of one size and pattern, performing exactly the same operations on a single variety of work, it is true that very little would remain to be done, but this condition of affairs rarely obtains. Generally speaking, it remains true that departmentalization is quite a separate transaction from the interlocking of charges with costs.

An important function discharged by shop cost as distinguished from prime cost is the information afforded to the draughtsman when considering the question of design. The designer has to arrange to give full play to the actual conditions of the shop much as an architect has to consider the circumstances of the site, by which he is often fettered.

It is not a question of producing a purely theoretical plan free from all limitations of practice that he has to study, but how to arrange to make a given article with a given set of plans, and a given organization, so that the capabilities of these fixed elements are utilized to the utmost.

It will be evident that the best chance of doing this exists where the actual shop conditions are fully known, and inter-related with the work already done. Great discrimination is of course necessary in considering these factors, but it is the natural course of things that as the industry increases in complexity, the intelligence required to

conduct it successfully requires more and more careful training and selection. This is a tendency against which it is useless to protest.

A not unimportant matter on which the shop-charges question has a very definite bearing is that of valuation for stock taking. When it is considered that the truth of a balance sheet must obtain all its vitality from the valuation of finished work and of work in progress through the shops, the immense importance of a correct basis for such valuation will appear. Unfortunately, there appears to be no sort of uniformity of practice with regard to this matter. In some cases prime cost is taken as the basis of reckoning; in other cases arbitrary percentages are added, and even in these latter there is a divergence of practice. Sometimes they are added to time only, sometimes to prime cost, but in no case, within my knowledge,\* is any attempt made to discriminate between various classes of manufactures. Now, a moment's consideration will suffice to show that any system of general percentage must be most unfair. So must the method of basing valuation on simple prime cost. The reason is obvious. All valuation is an attempt to represent certain facts. The facts are indubitably these: the charges incident on a variety of articles as truly represent part of the cost of such

\* Exception must be made, of course, in the case of works organized on the writer's system.

articles as the actual direct wages paid on them. And these charges are rarely, it would be safe to say never, identical in their incidence on different classes of articles nor are they constant from period to period. Therefore an attempt to represent their value either by ignoring this factor of production or by applying an arbitrary increment or percentage equally on all, will produce not any approach to facts, but merely a fancy figure, which will be not even constant in its error. It is, in fact, a guess, and not the less so because based on figures. Arrangements of this kind probably originated the unkind saying that figures will prove anything, "except facts."

The cost of production, as dealt with in this discussion, will be considered uniformly as divided into three great divisions. First, the bare cost of wages and materials, which will be called Prime or No. 1 cost. Secondly, the prime cost plus the expense of production incurred in passing through the shops; this I shall refer to as Works or No. 2 cost. Thirdly, the works cost plus the expenses of the commercial management and selling organization, which is termed Inclusive or No. 3 cost. This classification will be remembered better by examination of the diagram (Figure 1) which represents the total sale price of an article dissected into its constituent factors.

In this diagram it will be seen that the cost of

materials and of wages, taken together, make up Prime or No. 1 cost. Material, wages, and shop establishment charges make up No. 2 or Works cost. And material, wages, shop charges, and general establishment charges make up Inclusive or No. 3 cost. This last, subtracted from the sale price, gives the profit on that order.

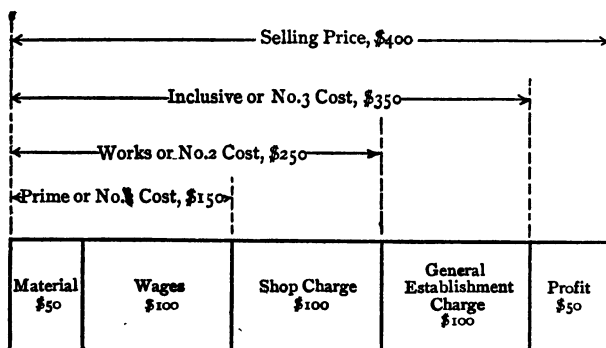


FIG. I. ANALYSIS OF THE SALE PRICE OF A MANUFACTURED ARTICLE.

The organization of no works can be considered complete until it is able not merely to connect its costs of *all classes* with its jobs, but also to check its financial position by aggregating its profits on sales item by item. Of course the latter process is merely a corollary or deduction from the cost factor. Having ascertained the latter in the form shown by the diagram, the net profit on any sale becomes a trifling matter of arithmetic.

Some attention should be given to a clear understanding at this stage of the very definite line drawn between works cost and inclusive cost. Works cost, as its name implies, represents the expenditure of all sorts upon the work, *up to its delivery into warehouse*. It is the cost of production, and of nothing but production. Inclusive cost is works cost plus what the commercial arm has spent on it to effect a sale. The distinction will become clearer if we suppose the case of a business having its works in the country, and its commercial office in the metropolis. The expenses of the former would fall into works cost, and the expenditure of the latter would be classed as general establishment charges. It is, of course, understood that all the correspondence, packing, etc., was performed by the metropolitan office, and that the works has nothing to do but to manufacture.

There are, of course, certain expenses which may be doubtful and their inclusion in one division or another is subject to the actual circumstances. Of this kind are draughtsmen. In some cases, the cost of drawings is certainly a works expenditure and chargeable to the job. The same applies to patterns. But, generally speaking, the basis of division is this: if a drawing or pattern is chargeable against a given order, it should be treated as part of prime cost, but in all other cases as a general establishment charge—never in any case as a shop establishment charge.

The necessity for and the justice of this distinction between shop charges and general charges (works cost and inclusive cost) hardly needs insistence. It has been ably and exhaustively argued in the work of Mr. Slater Lewis, already referred to, but the argument may be briefly recapitulated here.

Nothing is naturally more distinct than the operations of making and selling. They require different instincts and widely separate talents. An undertaking may be most efficiently organized and managed on one of these sides, and yet be unsuccessful, because what is gained in one set of efforts is lost in another. What is more useful, therefore, than to make this natural division of work to be reflected by a similar division in the system of accounting? It is the easiest and simplest of all the modifications with which we shall meet, because it is the most obvious and fundamental.

In the chapters which follow, works cost will occupy nearly the whole of the field. This is because as yet general establishment charges are not capable of any great amount of detailed analysis. But by keeping them separate and distinct, and thus excluding them from affecting the operations of the works, we are enabled to follow the latter in very great detail, and to feel sure of our result.

## CHAPTER II.

### DISTRIBUTING EXPENSE TO INDIVIDUAL JOBS.

**A**SSUMPTION is made in what follows that a system of taking out prime costs is already in use, which summarizes the expenditure in each department into: (1), wages and materials expended on stock or customers' orders; and (2), other expenditure, such as repairs, supervision, and similar indirect items of expense.

Having obtained the total of indirect expenditure for any shop, there are several recognized ways of establishing a ratio or proportion between the value of work done in a given period, such as a month, and this indirect expense. This ratio may be established as a percentage on wages, or expenses may be divided over the numbers of hours worked, or they may be distributed in some approach to a differential method of treatment by means of machine rates varying in value. Each of these methods must be considered in detail.

#### THE PERCENTAGE-ON-WAGES METHOD.

Where any attempt is made to distribute shop charges over work at all, this method is the one most usually employed, at any rate in Great Britain.



The probable reason of this is that, though capable of considerable refinements, it is as usually employed a "handy," or in other words a rough-and-ready, method. In order to distribute shop charges on this plan, all that is necessary is to obtain first, the total of charges; the second, total of wages on actual orders during, say, a month in each case, and—find the percentage of one to the other. Thus, if in a given month we have spent:

DIRECT	ITEMS. EXPENDITURE ON ORDERS.	WAGES. MATERIAL.		TOTAL.
		100	56	
Shop Establishment Charges:				
	Repairs and Maintenance ...	15	4	19
	Spoiled Work .....	2	1	3
	Supervision .....	5	..	5
	General Laboring .....	7	..	7
	Share of Storekeeping, } Timekeeping, Etc .....	..	..	8
	Proportion of Rents, Rates } Power, Light Heat, } Etc. for this Department }	..	..	17
Total of Shop Charges . . . .		29	5	59
Total Wages and Material } in Shop .....		129	61	..

We find that as against \$100 direct wages on order, we have an indirect expenditure of \$59, or, in other terms, our shop establishment charges are 59 per cent of direct wages in that shop for the period in question. This is, of course, very simple. It is also as usually worked very inexact. It is true that as regards the output of the shop *as a whole* a fair idea is obtained of the general cost of

the work—that is, of its works (or No. 2) cost. And in the case of a shop with machines all of a size and kind, performing practically identical operations by means of a fairly average wages rate, it is not alarmingly incorrect.

If, however, we apply this method to a shop in which large and small machines, highly paid and cheap labor, heavy castings and small parts, are all in operation together, then the result, unless measures are taken to supplement it, is no longer trustworthy.

The reason why, under these conditions, it is no longer to be regarded as a scientific method is not far to seek. The case of the difference in the value of work done on different machines as regards one item alone, viz., the interest factor, has already been alluded to. But this is not the only point of differentiation. The space occupied by machines varies, the power taken by them varies. And in the case of men at high and low rates of wages, the cheap man takes up as much room as the expensive man, and probably takes much more supervision; large parts, again, use powerful cranes and occupy the time of laborers in their progress about the shops, to say nothing of the room required for their evolutions.

Now on the simple percentage plan, it is not only that these factors of difference are ignored, but the basis actually used for the distribution of

charges, viz., the cost of the job as measured in dollars or shillings, though apparently a "natural" one, is really quite arbitrary and without any real relation to the actual problem.

That this is so will be allowed when it is considered that the effect *in the costs* of lowering the wages rate of a man, is also to reduce the amount of establishment charges which gets allocated to the job by the system of percentages. If this represented anything like the facts it would not be so bad; but unfortunately, the highest probability exists that by substituting a poorly paid man for a good man on any particular job, the true proportion of charges would be actually increased. He would take longer, for one thing, yet as his longer time occupied is counterbalanced by a smaller total of wages, the percentage would not be increased. Again, he would probably absorb more of the foremen's attention, but this would not show in the accounts. In short, the result of the change would really be to increase the cost of the works—the works cost—but the apparent effect would be to reduce it, because the prime cost might be reduced, and the burden of the charges which were before allocated to that job would fall on other jobs with which it has nothing to do.

In certain kinds of business it is possible to apply a compensating arrangement. Where the class of work is fairly steady, and the bulk of the

work done in any one shop is on different parts of the same kind of machine, certain carefully considered but still to a large extent arbitrary variations of the incidence may be arranged. The work may be divided, for example, into three or more classes according to size of castings, such as heavy, medium, and light, the percentages being so adjusted that the heavy class takes  $x$  per cent more than the medium class, and the medium class  $y$  per cent more than the light class. By this means the whole of the shop charges will be distributed as before over the wages expended on orders, but not uniformly. The heavier work gets burdened more heavily than the light work, and therefore absorbs more, while the light work absorbs less than it would have done without this compensation.

The method requires, however, very elaborate and careful arrangements for determining: (1), the basis on which to divide the ratio of percentages; and (2), an equally close consideration of every article manufactured to decide in which class it should be included. Where this is done the method gives satisfaction; but it should not be forgotten that anything like hasty or careless dealing with the varying factors vitiates the value of the whole method. But with proper precautions it is a very convenient and elastic system, if confined to shops which fulfil the conditions above stated.

## THE HOURLY-BURDEN PLAN.

The broad principle of this method, in all its varieties, is based on the consideration that the shop as a whole may be considered as a factor of production, and can be charged for at an hourly rate against the work done on orders. The standing charges, the cost of maintenance, and the shop organization, are summarized as for the percentage plan, but the resulting figure is dealt with quite differently. Instead of spreading the shop charges over the cost of individual jobs, as measured by the direct wages spent, these charges are spread over them according to the number of hours during which work has been done on them.

ITEM.	WAGES.	MATERIAL.	TOTAL.
Total of Shop Charges.	29	5	59
(as before.)			
Total Hours Worked on Orders During Month—3,000 Hours.			
	\$59		
	= \$0.0197 per Hour Worked.		
	3000		

Thus, if we have \$59 as before, representing the whole of the shop charges for one month, we require to ascertain the time actually worked reproductively, that is on orders, and reduce this total of \$59 to a rate per hour on such reproductive time. There are variations of this method, but the principle is the same in all, viz., making an hourly charge for the shop organization and expenses.

A little consideration will show that this method

may produce quite a different works (or No. 2) cost from the same set of figures arranged on the percentage plan. It is claimed by the advocates of the hourly-burden method that it is far superior in that a nearer approach to the real conditions of work, i. e., to *facts*, is realized by making the hour rather than the dollar or shilling the basis of distribution. Some of the obvious faults of the percentage system are undoubtedly removed by it. The elimination of wages as the basis of distribution certainly removes the great reproach of the former system, viz., that it makes the works cost on any particular job slavishly follow the prime-cost figures, and therefore tends to make cheap labor bungling over a job for an unnecessarily long time appear profitable. It brings into full prominence the essential fact that to have work hanging about is a costly proceeding, however low-priced the actual labor may be. Perhaps this is the most important feature of the method—it contributes to a clearer view, to more exact picturing, of the immense importance of the time factor in production.

But when we consider the system as fulfilling the rôle of a scientific method of apportioning establishment charges, it is easily seen to fall short of perfection in a serious sense. Just as the percentage method stakes all upon the single factor of wages, so the hourly-burden plan stakes everything upon the single factor of time. The mere statement of

this peculiarity is sufficient to show that we have here a method which sacrifices a great deal for the sake of simplicity. To take one item alone, no discrimination between large and costly and small and cheap machines is brought into play. Simplicity is a good thing, but as an end in itself is worth nothing. What is required is an exact method of apportioning establishment charges, a method which will allow us to obtain figures which are closely approximate to facts, because they follow the actual and known conditions obtaining in the shops, as far as we know how to make them. If any method fails to do this, when it can be done in greater degree by another method, its simplicity is nothing in its favor. At the same time, it may be allowed that for particular conditions the hourly-burden plan will give satisfactory results. In shops, for example, where there is uniformity in the class of machines employed and in the kinds of work passing through, the simple hourly burden gives substantial accuracy. These, it will be observed, are also the conditions under which the percentage plan has been stated to be applicable. The reason of this is not the similarity of the two methods, but because in such cases, *the conditions are at a maximum of simplicity*. In other words, where we have a simple set of facts to represent, their representation is an equally simple matter.

We have here an important key to the discussion



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of the suitability of any system. Almost any method will represent simple conditions. But will any given method break down when the conditions become complex? This is the touchstone. As work is not arranged to suit methods of record, but *vice-versa*, it is evident that we must seek a method capable of recording with approximate accuracy under the most complex and difficult conditions. We may then feel quite secure that it will also record simple conditions in a simple manner. It is putting the cart before the horse to consider the simple matters first.

### THE MACHINE-RATE METHOD.

This is perhaps the oldest and most widespread of all. It is not a modern method. By this is meant that it belongs to a former period, in which the close accuracy, the monthly balances, and other refinements of accounting had not been heard of, and that therefore it cannot be considered as among the scientific systems of distributing shop establishment charges. In fact, it does not usually pretend to deal with shop charges, in the general sense, at all. The usual function of the machine rate is to burden the work with a charge proportionate to the interest on and the wear and tear of the machine. As usually arranged it is an hourly charge, based on the probable life of the machine under full work. In this sense it is intelligible.



But cases do exist in which it has been attempted to make it represent more than this, by increasing the amount arbitrarily, so as really to charge part of the shop expenses through it as well. This is exceedingly bad practice. Why it is bad will be seen presently. The machine rate may be looked upon as belonging to the Silurian epoch of shop accounting. It is the ichthyosaurus of expense systems. It attempts to do in a heavy, blundering way what is hardly worth doing at all. Considered in its legitimate aspect—as a means of distributing the burden of interest and depreciation on any machine over the work done on that machine—it does this successfully under one set of conditions only, viz., if such machine is never for a moment idle. This being its condition of maximum perfection, it follows that the greater the proportion of idle hours, the less accurate will be the results obtained from the method. A little consideration will lead to the conclusion that, in a slack time, the work done in the shops will be receiving just the same burden as in a busy time, with every machine running full. The balance of expenditure not allocated to jobs is just lost sight of.

This is a serious enough matter if we consider the machine rate as a charge for interest and depreciation only. But if we look on it, as is sometimes done, as a medium for distributing some (unknown) fraction of the shop charges, the absurdity of the

method will be obvious. It will not compare for this purpose with either the percentage plan or the hourly-burden plan. Yet with all its impossibility as a modern system, the machine rate has certain practical advantages, shared by no other method. It *does* take into account just what is missed by the former systems, viz., the variation in the cost of work done on different types of machines. This feature, which practical instinct easily recognizes, has secured its survival. Though it cannot be considered as a good method, it has had its value as a compromise between bare prime cost and a regular apportionment of charges. It tells something definite—something which is valuable, but which is neither as definite nor as valuable as it might be.

The fact that it establishes a permanent relation between the work and the machine is a valuable feature. By a permanent relation is meant a relation which does not change or fluctuate with conditions of work in the shop. The charge for the machine being always  $x$ , whether the shop is slack or busy, brings a very steady factor into account, which is available as a datum of comparison between work done at different periods as no other factor is available. The prime cost, for instance, is no absolute guide for comparison of efficiencies, since rates of wages vary not always in direct proportion to personal output. The shop charges on

the two former systems also fluctuate violently, but the machine-rate value remains constant. This is because it is a pure function of time. It is true that for all practical purposes the time itself is the very factor which it is desirable to know. And remembering this, it is not difficult to see that we can obtain this information without necessarily being bound to a non-fluctuating charge.

#### GENERAL RÉSUMÉ OF THE FOREGOING METHODS.

There have now been passed in review the three fundamental methods of allocating shop charges over work so as to produce works (or No. 2) cost. Of these only the first and second give a real No. 2 cost in the sense that *all* the charges for a given period are spread over productive work.

It will have been seen that there are two distinct ways only of doing this. The charges must be distributed either on "wages value" as a basis, or on "time occupied" as a basis. For ordinary manufacturing operations there is no other alternative. In certain special industries a distribution on units of weight or measure might be necessary, but we need not pause to consider these. Generally speaking, we have to choose between wages value or time as a unit on which to distribute.

The weak point of the percentage and the hourly-burden system is that it is an *averaged* result at which we ultimately arrive, and which we try to

regard as the true works or No. 2 cost. Now, it is just as wrong to average such charges as it would be to throw all wages paid into one sum, and average this over the number of hours worked, taking the result as a true wages cost. In the case of wages this is seen to be an absurdity, and no question of simplicity or convenience would be allowed to stand in the way of collecting the actual wage cost of each job in an engineering works. An average-wages charge is easily seen to be misleading and dangerous.

Yet in certain cases where only one class and size of article is turned out in one shop, this averaged-wages cost, although several variations of rates may be included in the total sum before averaging, is not only useful but is actually used. It works successfully in such cases because of the extreme simplicity of the conditions. Only one set of factors being concerned, viz., a single process and a single variety and size of article, the average charge for wages sops up inequalities of rates, which inequalities are not due to exigencies of manufacture but to exigencies of employment. Here we have an excellent example of a method of accounting, correct within narrow limits, but obviously breaking down the moment those limits are exceeded. The impropriety of applying such a system of averaging wages to a shop in which several processes, different grades of workers, and

separate sizes and classes of articles are concerned, needs no argument. It can be realized at a glance. But this case of wages is exactly on all fours with the case of shop establishment charges. Under very simple and uniform conditions, a method of distributing establishment charges which averages such charges per dollar of wages or per hour of time is correct, but in proportion as we depart from these simple conditions we also depart from accuracy.

This is not a mere theoretical and pedantic distinction. These shop charges frequently amount to 100 per cent, 125 per cent, and even much more of the direct wages. It is therefore often actually more important that they should be correct than that the actual wages cost should be correct. If we have to put a dime and also a quarter in a certain collecting bag, it is certainly more important that the quarter should not go astray than that the dime should be looked after.

It is true that by no possible method can we avoid averaging shop charges to a certain extent. But we can reduce this extent to a minimum, thereby attaining a high average of accuracy. In the end we have, of course, to choose between one or other of the alternatives already mentioned, viz., wages or hours, for the distribution. Yet by avoiding the attempt to force simplicity of results into the representations of conditions which are

by no means simple, and by letting our method follow the natural lines of the actual complexity, we can arrive at results which are no longer averaged to anything like the same extent, but are on the contrary highly differentiated.

#### THE ELEMENTS OF AN IDEAL SYSTEM.

A little preliminary consideration may be given to the features which might be looked for in an ideally perfect method of interconnecting establishment charges and work. Having entirely cleared one's mind of any traditions of what is usual or conventional under the averaging *régime*, it becomes visible that several of the items of shop charge are naturally connected with the use and employment of property or plant, and are in the nature of a rent paid for these. In this category are:—Rent, taxes, and insurance on buildings, interest, depreciation on machines, on cranes, shafts, motors, etc. Other items are connected with other factors of production. Power, with the use of same by machines; cost of lighting or heating, with area of floor space usually lighted or heated—in short, not to go into detail at this stage, it is readily seen that a large number of shop charges are by no means general in their real nature but can be narrowed down to definite points of incidence.

In an ideal system, it would therefore be expected that this narrowing down should be carried

as far as it was practically profitable to do so, and that only such expenses as were wholly general and could not by any reasonable analysis be connected with definite points of incidence, should be treated as general shop charges, and therefore left to be averaged on the former basis. This looks complex. And undoubtedly under the most favorable circumstances the preparations *are* complex; but, as will be seen, a working method (which after all is the only thing in which simplicity is important, or at any rate essential) can be devised which is not more troublesome than other methods of distributing shop charges. Before going on in the ensuing chapters to explain the preliminary steps and the methods of working, an idea will be given of the new point of view on which the method advocated is based.

We have seen that it is a very simple matter to represent the conditions of a shop in which the work is uniform and all the conditions constant. All the charge factors, whatever their real point of incidence, press equally on all portions of the work in such a shop, and there is therefore no differentiation possible between different portions of the work. In a mixed shop, on the contrary, these factors do not press equally—power, floor space occupied, with its burden of rent, interest, insurance, lighting, etc., interest on capital outlay for machines—all vary as between jobs. There is no justification

for treating such charges as an average if it can possibly be avoided. Hence it is evident that in the distribution of such charges the shop can no longer be considered as a unit, but something smaller must be taken. Of course, to subdivide the shop into smaller areas would be no solution of this problem. The mixture of the factors of incidence would be as great in half a shop as in a whole shop. A new point of view is necessary.

It becomes desirable to look at what the expression "shop" really signifies. If we regard the shop as an organic whole (which it no doubt is, or should be,) we get no new light. We may perceive clearly enough the cross-fire of factors of incidence bearing unequally in different parts of it, but are no nearer their disentanglement. But if we regard the shop as a collection of small "production centres," each differing from the other, with certain common connecting bonds which are alone the average or general factors of incidence, then the problem suddenly becomes clear. If, instead of turning our energies to cover up the natural differences between these "production centres" and make an average of them, we devote our attention to giving the fullest play to this difference, we may claim to have subdivided the shop in a new sense, and to a new end.

A production centre is, of course, either a machine or a bench at which a hand craftsman works.



Each of these is in the position of a little shop carrying on one little special industry, paying rent for the floor space occupied, interest for the capital involved, depreciation for the wear and tear, and so on, *quite independently of what may be paid by other production centres* in the same shop. Then, in addition to this, there will be a separate debit representing those items of incidence which can only be treated as an average all-round charge. The cost of each production centre is, of course, laden onto the work by a rate per hour. Here we seem to have come back to a machine-rate method, subject to all the defects of that method, particularly as regard the idle hours. If the new process ended here it would be of little use, but it does not end here.

It will be seen, when this portion of the subject is reached, that whilst the rate for the production centre is kept constant, the waste of resources due to idle production centres is not lost sight of, but finds its due place in the works cost simply enough, and in such a way that it has a special significance of its own.

One prominent advantage of the plan of reducing each shop to its constituent production centres as a basis for distributing establishment charges should be noticed. The most heterogenous processes may be carried on side by side. Having narrowed down the greater portion of the shop charges to their

fundamental points of incidence, we need no longer be afraid of any conditions, however complex. Unlike the averaging methods, almost any actual working conditions can be faithfully represented on this system. This is because each production centre is virtually independent of any other, and therefore complexity is indifferent to it.

It will be seen, for instance, that it is applicable to heavy engineering work, to mass production, and even to that most complex class of work, in which almost-automatic machines work side by side with ordinary machine tools.

### CHAPTER III.

#### THE SCIENTIFIC MACHINE RATE AND THE SUPPLEMENTARY RATE.

**I**N the preceding chapter, an outline of a new basis of determining the incidence of shop establishment charges was given. Before passing to consideration of the preliminary measures necessary to its introduction, the effect and results of the method will be detailed. The apparent similarity of the system to the old device of the machine rate has been alluded to; the points of difference will now be brought into prominence. It will be remembered that the principle on which the proposed method was stated to be based, was that of dividing each shop up into its constituent "production centres" and giving full play to the natural differences between these as far as practicable, instead (as on the averaging plan) of throwing them into one common receptacle or lump sum of shop charges. It was also pointed out that this of itself would be subject to all the defects of the old machine-rate method, inasmuch as the problem of idle hours is still unsolved. There is also the problem of those actually general charges, which

cannot by any reasonable allocation be connected with particular production centres.

Leaving these latter out of account for the moment, it will be seen that, admitting all machines or production centres to be running full time, it would be possible so to adjust the rents or machine rates payable for the use of these centres during one hour, that at the end of any period, say a month, the whole of the shop charges would find themselves attached to particular jobs, according to the time taken by each job.

TOTAL OF SHOP CHARGES FOR 1 MONTH - \$200.

MACHINE	WORKING HOURS PER MONTH.	RATE PER HOUR ON NEW PLAN.	MONTHLY EARNINGS ON NEW PLAN.
A	200	40 Cents	\$80.00
B	200	30 Cents	60.00
C	200	20 Cents	40.00
D	200	10 Cents	20.00

Total hours worked by all four machines, 800. Hourly burden =  $\frac{\$200}{800} = 25$  cents.

Total distributed by hourly-burden plan, 800 hrs. @ 25 cts. = \$200.00.

Total distributed by machine rates on new plan, \$80 + 60 + 40 + 20 = \$200.00.

In the above schedule, there has been given the case of a certain shop, in which the monthly total of shop charges was \$200. The time made by the constituent production centres, viz., machines A, B, C, and D, was 200 hours each, or 800 in all. Now on the hourly-burden plan this would give an aver-

age hourly rate of 25 cents for all jobs, on whichever machines they happened to have been done.

But it is assumed that the application of the new method and thereby the separation instead of lumping together of the incidence of charges has resulted in the rates of machine A being fixed at 40 cents, of B at 30 cents, of C at 20 cents, and of D at 10 cents. Again assuming the full number of hours to be worked, it is easy to see that we get considerable differences in the resulting incidence of shop charges on the two plans. The charge, for instance, on a job which occupied 5 hours of machine D and 1 hour of machine A would be;

On hourly-burden plan—6 hours at 25 cents = \$1.50.

On new plan—5 hours on D at 10 cents = 50 cents; 1 hour on A at 40 cents = 40 cents; total, 50 + 40 = 90 cents.

We may now consider what would be the incidence under the percentage-of-wages method of distribution. Let it be assumed that the wages of operators on A and B machines are 20 cents per hour, and of operators on C and D machines 15 cents per hour. Reckoning, as before, 200 hours per month, for each machine, we find:—

Total wages for one month, \$140; and as shop charges are \$200 this gives an average of 142 per cent on wages-value for all work done, by whichever operator or whichever machine concerned.

Hence we get the charges incident on the job we have been considering:—

5 hours of operator on D at 15 cents = 75 cents,  
on which charges at 142.9 per cent = \$1.07.

1 hour of operator on A at 20 = 20 cents, on  
which charges at 142.9 per cent = 28 cents.

Total charges for job \$1.07 + \$0.28 = \$1.35.

We have now worked out this job on three methods, and find different results in each case, viz:—

On hourly-burden plan.....	\$1.50
On new plan.....	0.90
On percentage method.....	1.35

Which of these is most correct?

The nearness of results obtained by the hourly-burden and the percentage plan makes these two methods apparently support each other. But this in reality is due to the fact that we have assumed a very slight difference (only 5 cents) between the highest and lowest wages rate. This contributes to make the real basis of distribution as nearly uniform in this case as the hourly burden. By this is meant that the value of an hour having been made nearly uniform, it is much the same in effect whether we distribute on hours or value of hours. It will be recognized that in proportion as wages rates differ, so will the discrepancy between the distribution on the hour and on the hour-

value increase. Between these two methods there is already a difference of 15 cents, which, as just shown, might easily have been much greater if the difference in the assumed wages rates had been made larger. To begin with then, let us ask which of these two may be considered the more accurate. The discrepancy being clearly due to the introduction of the wages factor as a measure of incidence, we need only inquire whether this lowering of the charge under the percentage system is a nearer approach to truth than the other.

If we assume that the \$200 of shop charge is wholly made up of standing expenses, rent, interest, depreciation, and such-like, we must decide in favor of the nearer correctness of the hourly-burden plan in principle. It at least is based on an invariable basis, which, though not representing the real state of affairs, is constant in its error. But we can easily see that the other result has more of the element of chance in it. It will vary according to just what man has happened to be on the particular job. And if the worker did not receive any wages at all, the charges would be reduced to nil.

This objection still holds, though in the particular job cited the percentage plan has given us a figure nearer to that provided by the new plan than the hourly-burden figure, which we have notwithstanding argued to be the more correct in principle. This paradox is explained by the consideration

that had by any chance the wages not been scaled proportionately to the machine rates, the discrepancy would be far greater between the new and the percentage, than between the new and the hourly plan. In the case of a low-waged operator working a highly rated machine, and *vice versa*, the discrepancies would plainly pass from positive to negative on the percentage plan, whilst on the other two plans they would not vary. The fault of the percentage plan is, then, that it fluctuates according to a factor which cannot be considered as really representing a true and corresponding variation in the incidence of shop charges. The fault of the hourly-burden plan is that it does not vary at all. As between these two evils, our preference must be for that one which produces the most constant error.

It has been assumed in the above argument that the new plan does produce a result not merely relatively more correct than either of the two others, but that it gives a normal result closely connected with actual conditions of work. Remembering that we are still discussing the case of a shop in which all machines are making full time, it is difficult to see how we are to avoid coming to this conclusion. It is evident that the standing charges, at any rate, comprising such items as interest and depreciation on particular machines, the proportion of rent, taxes, insurance, heating, etc. (which



may be considered as reduced to a certain uniform charge for each square yard of floor space, and thus debited according to the working space occupied by any machine) and all charges allied to these, can be as properly assigned to particular production centres as in the case of rents in large buildings which are let out in subdivided areas to tenants.

No sophistry is needed to assume that these charges are in the nature of such rents, for it might easily happen that in a certain building a number of separate little shops were established, each containing one machine, all making some particular part or working on some particular operation of the same class of goods, but each shop occupied, not by a wage earner, but by an independent mechanic, who rented his space, power, and machinery, and sold the finished product to the lessor. Now, in such case, what would be the shop charges of these mechanics? Clearly they would comprise as their chief if not their only item just the rent paid. And this rent would be made up of: (1) interest; (2), depreciation; (3) insurance; (4) profit on the capital involved in the building, machine, and power-transmitting and generating plant. There would also most probably be a separate charge for power according to the quantity consumed.

Exclude the item of profit, which is not included in the case of a shop charge, and we find that we

have approached most closely to the new plan of reducing any shop into its constituent production centres. No one would pretend that there was any insuperable difficulty involved in fixing a just rent for little shops let out on this plan. Nor can there be any more difficulty in fixing the proper charges for each production centre in a large shop. The little shops are, in fact, a large shop when we take away the partitions which divide them. The presence of these partitions certainly seems to make the problem more definite and concrete, but this is a mere illusion. There is a new point of view involved, which, once grasped, enables us to see separately things which otherwise have a look of conglomeration.

This illustration of the little independent shops is also useful in helping to discuss the question of idle hours. In each of these little shops, whether idle or busy, the rent is going on all the time. Only the charge for power might conceivably be stopped whilst the shop was shut. Now if the mechanic in one of these shops is only working half his time, it is pretty clear that he must double his rate of distribution on such work as he does, if he is to distribute his month's rent over his month's work. But, instead of doubling his rate, he might continue to charge at the normal rate, and then at the month end find how much he was yet in arrear, and distribute this undistributed amount only as a *supple-*

*mentary rate.* In this way he would benefit in two ways. First, his normal rate being constant, he can compare costs of jobs worked on at different periods; and secondly, the amount of the supplementary rate, (its ratio to the normal rate,) will serve as a very accurate barometer of the conditions under which he has been working at any period. If the normal rate has been so fixed, for instance, that when fully employed the supplementary rate was *nil* per cent of the normal, then if he observes it steadily rising 5 per cent, 10 per cent, 15 per cent, etc., he may be fairly sure that things are not going well with him. Of course, in the case of a little shop this would be perfectly clear to him without the aid of the rates to tell him so; but if we, now, throw down all the partitions and make the hundred separate little shops into one large general shop, this information may be very important indeed to those in authority.

The meaning of the term supplementary rate will now be understood. It is this which is the invaluable complement to the machine rate and which makes the great distinction between the new method and the old machine-rate method. *The supplementary rate is the undistributed balance of shop charges due to idleness of productive centres.*

In the illustration just given of the little shops, it will be seen that the undistributed balance due to slackness of one machine is thrown onto what-

ever work is done at all on that machine at some time or other. This is, of course, necessary in the case of independent little shops; but when the partitions are down, and we consider the case of a *bona fide* large shop with a number of production centres, this is no longer always possible, or even desirable from some points of view.

The idleness of a machine may or may not be considered as the fault of that machine. If, for instance, a machine was found to be idle nineteen-twentieths of its time, this might be due to one of two causes. Either the process was rare but essential, or the machine itself was largely superfluous. In the first case it would be eminently fair that the charge should be made very high when it was put in use, since the shop charges due to its presence and up-keep are indubitably incurred for the sake of this occasional use. In the second case it might be rather a matter of accommodation that the machine was retained at all, in which case the shop as a whole should bear the burden, and not the unlucky piece of work that should happen to be put on such machine at any time.

Here we have one of those matters of principle which are incapable of a general solution. The procedure proper would vary according to actual circumstances. Nevertheless, the general practice will probably be that idle machines shall get rid of the burden undistributed during their idle periods,

not by charging it specially in their working periods, but by transferring it to the general shop-charges account.

If we adopt this view of the usual destination of idle hour's burden, then we introduce at once a striking difference between the case of the little independent shops and the same machines considered as production centres of one large shop. In the former, idle time accumulates against its own machine; in the latter, all undistributed charges fall, not into the supplementary rate of particular machines, but into a general supplementary rate for the whole shop. It is also into this supplementary rate that the really general expenses of the shop fall.

The full outline of the new plan may now be seen. First, we consider each machine as an independent production centre, allocating to such centres all the expenses and charges which can, on reasonable analysis, be considered chargeable as a composite rent or machine rate for all the factors of production therein concerned. Second, we charge to a monthly shop-charges account all charges whatever incurred by that shop, including all the items specifically represented in fractional detail by the machine rates, and also including, of course, such general items as cannot be represented in the machine rates, of which the most obvious item is the supervision of a head, or foreman.

Then, as each machine is occupied on jobs, the latter are debited with so much per hour as machine rate, and at the end of the month the total amount so earned by the machines, *is deducted from the total shop expenses*, leaving a balance which is distributed over the same job as a *supplementary rate*. The ratio of the supplementary rate to the amount distributed by the machine rates forms a varying barometer, whose fluctuation is an index to the current efficiency of the shop.

It will, of course, be obvious, from what has already been said, that when the machines are all running full time the supplementary rate will consist of the general charges alone, such as the foreman's wages, which have not any individual connection with particular machines. This will be the condition of maximum efficiency in the shop. In proportion as all machines are not kept full of work all the time, this ratio of the supplementary rate to the amount distributed by the machine rates will begin to rise. The same effect will occur if any general kind of expenditure is increased.

While we have now seen the principle of the supplementary rate in detail, there yet remains the question on what basis the additional distribution shall take place. It may, for instance, be made into an ordinary hourly burden, or, which is simpler, may be reduced to a percentage of increase on the amount already distributed by the machine

rate. In the case of the shop whose charges amount to \$200, cited above, we may suppose:—

Machine A worked 120 hours @ 40 cents = \$48.00 for month.

Machine B worked 134 hours @ 30 cents = \$40.20 for month.

Machine C worked 169 hours @ 20 cents = \$33.80 for month.

Machine D worked 200 hours @ 10 cents = \$20.00 for month.

Total 623 hours. Total burden distributed, \$142.

Now deducting the total burden distributed through these machine rates, viz., \$142, from the full month's total of shop charges, viz., \$200, this leaves \$58 as a residual or undistributed amount. This forms the amount to be made the subject of the supplementary rate, but this itself may take two forms. It may be treated as an hourly burden, thus:—\$58 spread over 623 hours worked =  $9\frac{1}{2}$  cents per hour, which amount would have to be added to the amount already allocated by means of the machine rate; or, it might be that the residual amount is reduced to a percentage of the amount already distributed, thus:—total burden distributed by machine rates, \$142, residual amount, \$58; supplementary rate = per cent of increase on machine-rate amount, = 40.9 per cent. On this

latter plan the calculation of the correct incidence of shop charges is reduced to a very simple matter. First we get a certain amount charged against the job by the medium of the machine rate. This represents strictly the normal charge for that machine when under full work. Then at the month end we find the actual ratio of undistributed to distributed charges, and increase the debit against individual jobs accordingly. Thus:—

5 hours of machine B at 30 cents . . . .	= \$1.50
Supplementary rate at 40.9 per cent	= \$0.61
	———
Total charges.....	= \$2.11

This represents: (1), a proportion of the really general charges of the shop; and (2), an averaged distribution of the idle hours of any or all the machines in the shop.

As by the new machine-rate plan we have only subtracted from the total charges just those charges which *can* be connected with different production centres, it follows that, as regards the remainder, we are again face-to-face with the problem of finding a suitable basis on which to make the distribution of incidence.

The discussion of which is the better and more just way of distributing this residual amount, or supplementary rate, is worthy of some attention. Theoretically, as regards the idle hours,



we are averaging these over the work actually done, and this on the basis of their being considered as the fault of the shop as a whole, and not of any particular machine; but this may be as well attained by distributing the supplementary amount directly as an hourly burden, or a *pro rata* increase of amounts already charged through the machine rates.

The general, or, as we might more conveniently term them, the floating shop charges, plus the unallocated charges due to idle machines, are obviously not connected in any definite way with the work. They must be averaged on one basis or another, and the basis should be as constant—that is, subject to as few variations—as possible. This definition is better fulfilled by the hour than the hour-value. It is to be preferred, therefore, that the supplementary rate should be an hourly-burden rate. This, though not quite as simple in routine as the percentage form of supplementary rate just described, is the more accurate, because the incidence of the unallocated charges cannot be considered as varying within the value of different machines, but rather as pressing equally on all work done in the shop hour by hour, irrespective of whatever machine it may be done on. Nevertheless, the percentage supplementary rate is not without its arguments, since it means virtually a *pro rata* increase of machine rates in slack times, and

this is very much like what might be conceived to happen in the case of the separate little shops which have been used as an illustration, supposing that from one cause or another it became necessary for the landlord or owner to get the same return out of a smaller number of little shops. He would raise the rents. But this is exactly equivalent to a distribution of the supplementary rate as a percentage on the amount already distributed by machine rates.

This is in any case quite a different matter from a percentage distribution of shop charges on wages, and is not vitiated by the arguments already directed against that method. At this stage the matter may be left an open one, with preference in favor of the hourly-burden method of distributing the supplementary rate.

A summary of the complete scheme of machine rates and supplementary rates is now possible.

The principle followed is to connect expenditure with production centres, (which for the most part mean machines,) wherever this is possible and as far as it is possible. These charges are debited to jobs by machine rents or rates so carefully arranged as to include all of them. All these items of expenditure, and others which we term floating or general items (which do not enter into the composition of the machine rates at all) are collected into a monthly shop-charges account. This account

is relieved by the total of charges which have been debited to jobs during the month, by means of machine rates, leaving in the account a residual sum, which has yet to be got rid of and allocated to jobs. The supplementary rate affects this, either by reducing the residual amount to an hourly burden, distributed over the jobs in the usual way, or, more simply but somewhat less accurately, by finding the proportion or ratio of the residual sum to the amount already distributed by machine rates, and then increasing the amounts already allocated to each job by so much per cent.

It will be obvious that by this means *all* the charges will be distributed, leaving nothing in the charges account, and that if all the machines have made full time in the month, the supplementary rate will only represent the floating shop charges. In proportion as machines are idle the supplementary rate will rise, because only working hours are credited to the shop account as per the total of the machine rates found at the end of the month.

Thus we secure that each job gets its own expenses only attached to it, plus an average of floating charge and of what surplus may be due to slack times or inefficiency in the shop.

## CHAPTER IV.

### CLASSIFICATION AND DISSECTION OF SHOP CHARGES.

**I**N the preceding chapters the practical effects of the new method have been developed, special stress being laid on the desirability of discriminating in regard to the incidence of charges, rather than seeking, as has hitherto been the practice, to throw all classes of charge into one common collection of shop expenditure, and then to average down the whole per unit of time or wages.

It might be supposed that the steps necessary to do this were very difficult and cumbrous. This is not the case, unless indeed at the outset. Once roughed out and the various factors determined, the subsequent steps present no special difficulty. It will be useful to bear always in mind the illustration already given of the "little shops," forming part of a large mill and rented out to weekly or monthly tenants. If we follow the lines that would of necessity be followed by a landlord of such a building in order to the fair proportionment of rents, we shall not be far out of our course.

∨ The first item to be dealt with would probably

be the building. For the sake of simplicity, we may assume that this is of one story only. There is, of course, no difference in principle whether the building be one or several stories high. As a matter of fact this method was first worked out for and applied to a factory which consisted of two parts, one being an old building of five stories, and the other a modern shop of three. The process is the same in any case. All the factors of capital and revenue incident on such buildings are carefully mapped out. The capital invested in land has first place. To this is added the cost of the building. Particular care is taken to consider whether any inequalities in cost in the various parts of the latter are significant or accidental—that is, whether they have any special reference to the *uses* of that part. Having exhausted the capital items, they are reduced to floor areas. That is to say, every square foot of floor space not subject to special conditions is considered as representing so much capital outlay. Having determined this, the charges incident on the floor space due to this capital outlay are ascertained, then interest, ground rent, if any, taxes, insurance, depreciation of buildings—all are reduced to figures, and therefore to so many dollars or pounds per square foot of floor area. The first cost and working expenses of heating and ventilating appliances are treated on a similar footing.

When this is finished, with any factors peculiar to the local circumstances taken to account, we have obtained a pretty close idea of what rent charge is due to a production centre occupying say 13 square feet of working space. Whether we are determining the figures for the purposes of sub-letting our building or for determining the correct incidence of such items of expense in a large shop, makes no difference whatever to the process or its result. So many square feet of floor, so many dollars per annum out of pocket. If machine A occupies twice the space of machine B, it is costing us just twice as much to house it. There seems to be no escape from or alternative to this position.

Where shops are electrically lighted by overhead lights, the cost of this also is reduced to a floor-area basis. The items include:—charges due to the capital sunk in leads, switches, lamps, and in some cases where the light is generated on the premises, a due proportion of the cost of the generating plant; interest, insurance, and depreciation is taken out on these sums, and to the result is added the actual cost of power of current, carbons, cleaning, and so forth. Here again we get a rent representing the cost of lighting either one of our little shops or a given area of a large shop.

Two items are thus complete—first, a rent for the empty shop or area, second, the rent of the

same lighted up. The shop is, in fact, ready for occupation and use.

Probably the cost of power will be the next item dealt with. This is a more complex subject, still not insuperably so. The capital outlay on engines, boilers, motors and generators, main shafting, and pulleys being ascertained, and the resulting revenue charge therefrom, to this is added the running expenses—fuel, stoking, repairs, and so forth, reduced to a value per horse-power hour. There is not much difficulty in the broad working out of this figure, but the position of shops and various local details make the problem a little troublesome. In some cases the cost of power might not be the same in all parts of a large mill or scattered group of shops. This is a matter of which the practical aspect will vary, and no definite rulings are possible. It is evident that in many cases the charge for power should not be averaged. The cost of transmitting power to a distant shop might sometimes give rise later to the adoption of more efficient means of transmission, and this should of course show in the charges of that particular shop alone, and not reduce the average cost of power in other places which have nothing to do with the improvement. In most cases, however, the average charge per horse-power hour would meet the case fully.

The shops are now ready for the introduction of machines.

The charge due to interest, depreciation, and insurance on the value of machines is of course the item which the new method has in common with the ordinary machine-rate plan. These charges are calculated per annum and then reduced to a rate per hour, based on the probable number of hours the machine will be in work under normal conditions. Thus, if we take the annual work of any machine to be 2,500 hours, and the annual charge for interest, depreciation, and insurance to be \$150, this gives an hourly rate for these items of 6 cents. The ordinary machine rate being extensively understood at the present day, this particular item need not detain us farther. It should be noted, however, that the items of annual or hourly charge for interest, depreciation, and insurance do not form the whole machine rate as in the old method, but are one of many factors, of which several have already been described. The new method includes all that was signified by the old machine rate, and several other items as well.

It should be mentioned that along with each machine are included countershafts, fencing, belting, or motors, which are specially used to operate that machine alone. Some care is necessary to discriminate between what may belong to individual machines and what pertains more properly to the main system of power transmission.

In addition to the empty shop lighted and heated,



with its necessary main system of power, we have now considered the machines installed and ready for working. It will be evident that up to this point the charge incident on the work done on any machine will be made up of:—(1), a rent charge for the space occupied; (2), a charge for the capital sunk in the machine itself; and (3), a charge for power calculated according to the average amount used by the machine. None of these items can be imagined as being other than properly connected with the particular work done on any given machine, or as having on the other hand any connection with work done on other machines, whether they happen to be fixed under the same roof or not. We have, in fact, not so much differentiated as kept separate these factors of production cost, which on the ordinary methods of averaging shop charges are jumbled up in one common account.

There remain, however, other items perhaps not so definite, but yet capable of being worked out into reasonable approximations to the truth. Of these are the cost of overlooking and supervision, which are frequently special to a limited group of machines, as, for example, in the case of a sub-foreman in charge of a half-a-dozen screw-making machines or turret lathes. The approximate cost of such supervision for a year can be taken, divided by the number of machines, and reduced to an hourly rate per machine. The importance of con-

fining a special charge of this kind to just that class of work that incurs it, instead of letting it be part of a general shop charge and thus become spread over all the work of the shop, will be clear. The same result might, of course, be attained by a very elaborate system of allocating such overlookers' time on a cost sheet, but this would be much more troublesome and not appreciably more accurate than the plan proposed. It would be, in fact, *less* accurate, as will be seen when the question of partially-idle groups of machines is considered in the chapter on mass production.

The cost of tools may in some special cases be similarly treated, as for example the wheels on emery machines, cutters on milling machines, etc. This requires very cautious treatment. The same remark applies to charges for oil, or other material such as rouge, used in particular processes. Such materials frequently form a very serious item in the true cost of a process, and the justice of including them in the working expenses of a production centre will be felt if the case of the separate little shops is considered. The expenses of such a little shop doing polishing work by means of a buff wheel will be readily allowed to be made up of the standing charges already detailed plus the value of actual emery flour, rouge, etc., consumed on the work. And that substantial accuracy is attained by reducing such item of expense to a



charge per working hour will be admitted if we assume, as we are entitled to, that the same machine employed on the same class of work uses approximately in proportion to the amount of work got through. If from the evident circumstances of the case this were not so, then other arrangements would be necessary. The rate might, for example, be higher when engaged on one class of work than for another. It has already been stated that an item of this class requires very careful consideration.

The principal items of shop expenditure are now accounted for. Those remaining comprise the wages of general foremen, and the cost of repairs done to the buildings, to power, transmitting, lighting, and heating plant, and to the machines themselves. This latter question, being mixed up with that of depreciation, needs some discussion.

The usual view taken of a depreciation rate is that it is a fixed percentage, say 5 per cent, on a gradually lessening value. The effect of this is to transfer the cost of a machine from the plant account at the outset of its career to the depreciation fund at the end of its life. The value of the machine, if plotted graphically, would show a series of intermediate values year by year, each rather less than that of the previous year. From a financial point of view this is correct. As the machine wears out its value as an asset decreases, and the

provision for its renewal in the depreciation account increases. It is usually understood that the cost of minor repairs during working life is being met out of revenue. Therefore such repairs are properly a shop charge. Repairs or alterations, on the other hand, which practically give the machine a new lease of life, should be charged to plant account, wholly or partially, according to circumstances.

The question which interests us here is:—How should the cost of repairs which are met out of revenue be dealt with under the new method? It is evident that they can be either kept isolated from all others and in connection with the particular machine or item of plant that has incurred them, or else be treated as a really general shop charge, such as foreman's wages.

The principle of the new method being to keep all expenditure individualized, wherever it can be done, it follows that arrangements must be made to give the cost of repairs expression in the various rate factors which go to make up the total new machine rate.

As the charging of repairs is always an *ex post facto* transaction—that is, the work done by reason of which the repairs have become necessary cannot possibly be charged with them—it will serve the purpose if such repairs be averaged over half-yearly periods, though still kept confined to the

actual machines involved. Thus, if the power plant has been overhauled, the rent charge for power may be correspondingly increased at the next half-yearly balance, until such extra and abnormal expenditure has been wiped out. Generally, therefore, it will be seen that an estimated figure for cost of repairs is included in the various factors of the new machine rate, and this estimated charge is subject to periodical revision, if on examination it is found to be too high or too low.

It may be objected here that we are here breaking away from actual figures, and entering the nebulous region of estimated charges, which it is the purpose of the modern methods of accounting to avoid. The answer is that the breaking away is only temporary, and that the cost of repairs is more properly averaged over a more or less extended period than borne by any particular month in which they may happen to have been executed. And when it is remembered that the alternative to this method of averaging is the throwing of the cost of such repairs into the general fund of shop repairs, and spreading it over the work done in a given month, with which it has manifestly no proper connections, the propriety of the plan advocated will not be in doubt. By this means, the cost of repairs to a turret lathe, for example, is kept incident on the work of that turret lathe and no other; and as no particular item of the

current work can by any possibility be imagined to bear properly the burden of such repairs, no substantial injustice is done by a temporary want of coincidence between the actual rate of expenditure in repairs and the estimated rate. On the other hand, the individualizing principle is kept intact, and this is the more important object to keep in view.

Necessarily, the estimate for repairs included in the new machine rates must be no hastily determined or fancy figure. Throughout this method the preliminary determinations must be most carefully made. If this is done, then their subsequent variation will be an easy and almost automatic matter. If we recur to the case of the little shops, the justice of the foregoing contentions will be more clearly seen. It is evident that the cost of repairs to any one machine is part of the expenses of the little shop it is in. But, again, it would not be correct to charge with the extra cost the work which happened to be done in a week or month in which such repairs were carried out. More substantial justice would be done by estimating in advance the probable expenditure, and including that in the hourly rate charged on the work. Then, if at the end of a six-months' period it was found that this amount had been underestimated, the small amount representing the *difference* between what was actually spent and what was charged to jobs as an esti-

mated figure would be adjusted by raising the rate slightly.

The question of repairs done to the power plant or to the buildings of the little shops seems to present more difficulties. It seems clear that the landlord could not charge more for power or for rent because he had just spent a certain sum in repairs, merely to keep up the efficiency. On reflection this will be seen to strengthen the case for the averaging method. For the reason why no more rent could be charged is that, in fixing the rent in the first instance, the probability of a certain expenditure for repairs was foreseen and allowed for. It was, in fact, averaged in advance. And any discrepancy, any failure to estimate correctly the probable cost of repairs would, in the landlord's case, come out of his profit. It would be a dead loss to him. In the case of a large shop, however, there being no item corresponding to the landlord's profit to fall back on, the recovery of this unforeseen expenditure from the shop is the only course open. It must be got rid of by becoming an expense chargeable to work, and this is done simply enough by raising the rent charge per floor area, in the case of repairs to buildings, or per horsepower-hour, in the case of the power plant.

The treatment of all these items is thus identical, whether we are considering the little shops or a number of productive centres in a large shop. It

will be necessary now to consider the case of those charges which have no parallel in the little shops, such as foremen's wages, which press equally on a number of productive centres.

As there is no natural line of cleavage herein, no reasonable presumption in favor of such items being connected with one productive centre more than with another, we are compelled to treat them as really belonging to the category of general or non-individual shop charges, and thus to distribute them over the work as a whole, on the hourly-burden plan for preference. The principle of this method has already been explained, and there is nothing special in the treatment of these general items which differentiates them from the ordinary distribution of shop charges by hourly-burden. When all the machines or production centres are running full time, there is nothing in the shop-charges account to distribute but non-individual items. All the rest will have been already allocated to particular jobs by means of the new machine rates.

It is when this is the case that the differences between the present method and any previous one are seen at the full. Out of all the many items of expenditure going to make up the ordinary shop-charges account, which are usually lumped together and spread like a thin paste equally over all jobs in strict proportion to time occupied only, we find but



one or two items, themselves of relatively small amount, remaining to be treated in this way. All the main items of expenditure, by following the natural lines of action, have been kept immediately connected with the machines and therefore with the jobs done on such machines, on which they are properly incident. The large and expensive machine bears its own burden; so does the small and cheap machine. Their vicinity in the same shop does not have the effect of altering each other's shop-charge incidence. The introduction of a special overlooker on a small group of machines does not send up the hourly burden, and thus affect the work of the whole shop; it is confined in its effect to the machines and their work on which the increased expenditure was actually incurred. Throughout the items of expenditure have been not so much individualized as *kept* individualized, and thus preserved from mutual interference—just as much as if they were actually as well as hypothetically incurred in separate little shops. It would be hard to argue that this is not a decided gain or that it is not worth the trouble involved, whatever that may prove to be. If it is worth while attempting to connect establishment expenditure with work at all, it is certainly worth doing so in a way which closely represents actual facts.

Having thus considered in some detail the method of organizing the shop charges on the new method,

with the result that it is demonstrated that when all the productive centres are making full time the great bulk of shop expenditure finds its way to the actual jobs on which it has been incurred, it remains to show what happens when there is a large proportion of idle time in the shops. In such case, while the work actually going through will be charged as before with its due expense, there will obviously remain at the end of the month a certain amount of undistributed charges, exactly proportional to the idle time of the various productive centres.

This balance, together with the really general (or non-individual) shop charges, remains to be got rid of. This is effected by means of an hourly-burden rate. There are thus, under the new system, two rates which enter into the cost of each job; 1, the new machine rate, which remains the same whether the shop be busy or slack; and 2, the hourly-burden rate, which it is proposed to call the "supplementary rate," since by its aid we spread away all the residual charges, which would otherwise escape allotment. This rate necessarily rises when there is a large proportion of idle machines, and falls when idleness is at a minimum. The supplementary rate thus becomes a significant index to the commercial efficiency of the shop. It should be the aim of the authorities to keep the rate as low as possible. Its rise when work is plentiful will be a sign of the most automatic nature that something is going wrong.

It may occur to the reader that the more appropriate way of dealing with idle-machine time would be to distribute the unallotted machine-rate amounts, not as part of the general shop expense, but as a kind of supplementary machine rate, thus confining the effect of idleness to the particular machine in fault. This would certainly be the ideal method, but it is not practicable under ordinary circumstances; the reason being that if a machine were to work only one hour in a given month, all the burden of the other two-hundred-and-odd hours would be discharged on the unfortunate job done in that one hour. And worse still, if no work at all were done in the month the unallotted rate would either be lost altogether, or else thrown into the supplementary shop rate after all. We are obliged therefore, from motives of expediency, to look upon idle time as a kind of visitation of Providence which the whole shop ought to bear.

It is true, no doubt, that we do here depart from the parallel case of the little shops, by which we have endeavored to be guided. In their case, the accumulated burden due to slack times would have to be borne by whatever work was done in the month; but then in the extreme case of an almost complete idleness for a long period, such as a month, it would probably be a case of bankruptcy for the little shop. This alternative, as in the former case of the landlord's profit, has no parallel

in the case of a large shop embracing many productive centres. The shop as a whole properly comes to the rescue of the idle machine and shifts the unallotted burden onto its broader shoulders.

The full effect of the new method, as contrasted with the older averaging methods, such as either the percentage-on-wages or the hourly-burden plan, may be glanced at. Briefly, it may be said that in all three the whole of the charges incurred in the month is spread over the work done in that month. But whilst in the two former the distribution is on an arbitrary basis, in the new method the greater bulk of the charges allocated to a job are really what have been incurred under the actual conditions. If these conditions are varied, then although the number of hours or the direct wages may still remain the same, the amount debited to the job for shop charges will not remain the same. They will vary exactly in proportion as the resources called on to effect the variation are more or less expensive than before. On the two older methods they would not vary, provided the time or wages value remained unchanged.

Again, in the new machine rate we do get a factor of cost which is just as significant as the wages itself. It is a factor which varies as method varies. Cheaper methods of doing work will be promptly reflected in this factor. And the significance of the supplementary rate has already been alluded to.

In comparing two costs on the new method, we have three factors to read, each of which conveys special information:—1, direct wages; nothing need be said about this; 2, the machine rate; this will show whether a change of method or process has resulted in an economy if read in connection with wages. If cost has varied, it is easy to see wherein it has varied—the play of the three factors of time, wages, and machine rents being distinguishable—and deductions can be drawn whether there has been a net gain or loss by the change of method. For it will be seen that a decrease in wages may be counterbalanced by a rise in machine rent, or the shorter time taken by a high-priced man may be found to have a corresponding gain in a lower charge for machine rent. In fact, as before said, the play of the factors amongst themselves and their mutual relationships can be studied minutely. This is impossible on any of the averaging methods.

Finally, there is the supplementary rate, the third factor of cost. This will be of chief significance as showing what proportion of the total cost was due to the accidental features of the commercial situation at any period. This factor has never been separated before from the general body of the costs. On an averaging system, if we find a reduced cost today as against the cost of the same article a year ago, we cannot, if the method has in

the meantime been varied, say what is the reason of the reduction. The manufacturing efficiency due to method was intermixed with the commercial efficiency due to state of trade. In the new method, the state of trade or the general efficiency of management affect the supplementary rate alone, and a similar cost at two different periods might, if analyzed, show that what had been gained in method had been neutralized by a fall in the volume of trade, or by a muddled condition of shop organization.

In the next chapter some of the problems raised by the application of the method to mass production will be discussed, especially with regard to the influence of nearly automatic machines. One or two examples of job costs under varying conditions, and the lesson that may be read from an examination of them, will be presented.

## CHAPTER V.

### MASS PRODUCTION AND THE NEW MACHINE RATE.

**H**ITHERTO the case of an ordinary engineering shop has been under discussion, in which each production centre is in charge of an operator, whose wages form a separate item of cost. We have now to regard the case of factory production, in which it may not be profitable or necessary always to be taking out cost, because there is here not so much a question of separate jobs each different from the other, as of batches or lots of similar or closely similar articles going through time after time without variety in pattern.

It is also in connection with this class of work that we usually meet the automatic or nearly automatic machine, which introduces new difficulties into the question of costing, if not of shop charges. Take for instance the case of a group of small turret machines making some particular piece, for which the call is not absolutely constant. We will assume that there are five machines in the group, under the charge of one man, who sets tools and attends to all the wants of the process. Some of the

machines are always running, but the number varies from, say, three to the full five. What is the cost of the work under these varying circumstances, and what the proper incidence of shop charges?

The usual plan of taking out prime cost by means of time sheets evidently fails here, since this would lead to the same job being charged with  $\frac{1}{3}$  of the man's time today when he was working three machines, and with only  $\frac{1}{5}$  tomorrow when all five happen to be working. It is evident that this result is worthless for any practical purpose. And when it is considered that different articles may be running on each of the five machines, or three alike and two separate, or indeed any possible combination of five numbers, the confusion is still worse. The costs become quite meaningless.

Not so however with the new machine rate. As far as any particular job is concerned it is a matter of indifference if one, two, or all the five machines are in operation simultaneously. Whatever work is done receives its due debit of charges strictly in proportion to the time it takes. It is not even necessary that all the machines be exactly alike. One of the five may be a larger machine with a correspondingly higher rent charge. This matters nothing; just so much work as is done is burdened with its own proportion of machine rate, and therefore with its share of shop charges, quite irrespec-



tive of whether the other four are idle or working. As has already been explained, the idle time on each machine falls into the supplementary rate.

It matters not, therefore, from the point of view of the distribution of shop charges through the new machine rate, whether the machines are automatic or not. An automatic machine is still responsible for rent, interest, floor burden, cost of power, working expenses for oil, or other process supplies, just as an ordinary hand-operated machine is. And there is no difference in the method of determining these charges. If a hand machine were to be made automatic it would not alter the rate, except in so far as the alteration might have happened to alter some of the factors. If these were not altered at all, then the rate would also be unaltered.

But this does not get over the difficulty of the direct wages allocation. The prime cost is complicated by the change, undoubtedly. Every machine, however automatic, does unquestionably take up some part of a man's time, and the important point for cost-account purposes is to know what is the usual amount of time so taken up. In the case of a small automatic hack-saw, where the time occupied in changes is inconsiderable relative to the length of the process, no substantial injustice would be done by neglecting the wages factor altogether. But though this might answer in the case of an isolated machine, it certainly would not

be fair where several machines are in question; and where the automatic machine is in the direct line of the process-work it is evident that the wages difficulty must be solved.

The plan advocated here involves perhaps considerable breaking away from traditions. Briefly speaking, it is proposed in the case of automatic machines to consider wages of attendance as a factor of the new machine rate, based on the *maximum number of machines that can be worked simultaneously under the most favorable conditions*.

If, for example, we have a group of five automatic machines, capable of being operated simultaneously by one man, at \$10 per week, we consider the proper labor charge per machine per week to be \$2, which is equivalent to an hourly rate of 4 cents for each machine. This 4 cents is added to and made part of the new machine rate in each case. It follows, of course, from this that if one or more of the machines are idle, the unallotted wages fall into the supplementary rate along with other shop charges.

The plan of treating the wages on automatic machines as one element in the shop charges, and therefore suppressing their separate existence as an element of prime cost, is justifiable on several grounds. Whether machines are working or idle is a matter of general shop economy, varying according to the commercial situation or the effi-

ciency of organization. Now, within very wide limits where groups of automatic machines are concerned, it is fairly evident that under conditions of varying commercial efficiency, the number of machines in operation at any one time will vary from day to day, but not the wages bill. Therefore we shall not be far wrong in assuming that the adverse conditions due to slackness are more properly thrown upon the supplementary rate than visited upon the individual jobs. It has just been shown that the wages factor is one of the most variable elements in connection with a group of automatic machines. When all machines are working full time and things are at their condition of maximum efficiency, each job in the case of the five machines mentioned above is receiving a debit of  $\frac{1}{5}$  of the attendant's wages. When only three of the machines are working, each job done on those machines still continues on the new plan to receive  $\frac{1}{5}$ , and, as will readily be understood, the remaining  $\frac{2}{5}$  falls into the supplementary rate.

The practical advantages of this are: (1), the prime cost, being wholly composed of the machine rate which includes the wages factor, remains the same under all conditions of shop efficiency; and, (2), the unappropriated charges, including of course the balance of unallotted wages, instead of being visited on jobs which do not deserve to suffer, go to swell the supplementary rate which is, as

before explained, an index to the conditions of shop efficiency.

In the case of mixed shops where groups of automatic machines are ranged alongside hand-operated machines, some little care must be taken in arranging the wages factor as a component of the new machine rate. The wages of each operator in the mixed shop must be divided over such machines only as he is in the habit of working. It will be evident that should a man at a different rate of wages be put permanently on the machines, the machine rate will have to be altered; but in the case of a temporary substitution due to shop exigencies this should not be done. Any difference will be a matter of temporary accommodation, properly thrown onto the supplementary rate.

In the case of a shop given up entirely to factory production proper, such for instance as a grinding or polishing room, the advantages of the proposed method become still more obvious. After the ordinary machine-rate factors have been determined, a carefully estimated average wage rate is added on to the machine rate, and becomes part of it. Now such average rate is based, as before explained, upon the largest number of machines that can be worked by any one operator, or in cases where an operator has assistants such wages are added together and then averaged. In any such shop it frequently happens that workers are graded rather

by length of service than by competence. The averaging plan gets rid of these anomalies. Where differences in wages are not due to differences in work, it is most desirable that the costs should not vary because a higher or lower-waged operative has happened to be employed on any job.

In all these cases, the wages of operators which have been reduced to machine-rate factors are debited at the end of the month to the shop account. As this account is credited with all the machine earnings, it follows again that the balance of time not occupied to the utmost efficiency (as for instance in the case of three only out of five machines being worked) remains uncredited and thus is left to be dealt with in the supplementary rate.

The main point of difference between the new and former method may be briefly summarized. In the case of automatic machines, or of regular factory production, the wages of operators are treated as a shop charge, and a factor is added to the new machine rate by which such wages are charged to jobs on the basis of conditions of highest efficiency. A departure from these highest conditions does not reflect itself in the No. 1 cost of the job, but only in a higher supplementary rate distributed as a general shop charge by hourly burden.

When all the machines are running, and consequently the conditions of maximum efficiency are fulfilled, there will be nothing left in the shop

account but the really general shop charges, such as general foremen's wages, and consequently the effect will then be the same as if the wages of each operator were being distributed by time sheets over the jobs he is actually engaged upon.

The principle might be illustrated by saying that each machine is looked on as having a little bit of its operator's wages permanently attached to it. When the machine is working this fragment of wages is transferred to the jobs done, but if it is idle the fragment is transferred to the general shop expenses, and is distributed over the work generally as supplementary expenditure.

Reference has been made to regular factory operations which do not need that costs be continuously taken out. Where machines are constantly employed on the same article, or process, say slitting steel pens, it is not usually considered necessary to keep a regular record of production. Particular days are selected and the output of the machine for that day is taken. This, divided by the number of hours and multiplied by the machine rate, gives the No. 1 cost for the product, plus, of course, the number of hours multiplied by the supplementary rate (hourly burden) if No. 2 or shop cost is required. This being done from time to time is frequently considered to be sufficient check to ensure proper working. Whether it is really so or not will depend largely on circumstances, obviously.

In any case, to work out the figures required at the month end it is necessary to keep for each machine a machine time table, showing the hours during which it has been working. This is summarized at the month end, and the total month's earnings of the machine credited to the shop account. It makes no difference whether the costs per job or per batch are worked out or left unextended. As long as we know the numbers of hours worked, the supplementary rate can be found, and thus the true shop cost of any job, whether all the jobs are costed out, or only selected ones. By using a special form of machine time table, and by sending through the work in regular batches of say, 10,000 pieces, distinguishing each batch by a letter as, A, B, C, . . . Y, Z, etc., both these requirements can be met at once, and the cost of each batch recorded, even though it is only occasionally collected together in the regular form of a cost account. This can, of course, be done at leisure, without special arrangements. In many respects this is an advantage over the occasional watching of outputs, since these tests nearly always become known and can thus be manipulated by a cunning operator.

Space does not permit in this discussion of more than the outlines of the method being developed; the presentation of actual forms and accounts both for inaugurating and working the system must be left to another occasion. But as concrete figures





TABLE A.—SHOWING MACHINE TIME MADE. MACHINE EARNINGS IN JANUARY

No. of Machine.	Total Hours Worked in Month.	(New) Machine Rate Per Hour. Cents	Earnings—i.e. Amt. debited to Jobs thro. M. Rate. \$	Remarks.
1.....	200	4	8	Hand-operated machines. Wages allocated direct to job per time sheet.
2.....	200	7	14	
3.....	200	23	46	
4.....	200	25	50	
5.....	200	12	24	
6.....	200	10	20	
7.....	200	09	18	
8.....	200	34	68	
9.....	200	04	8	
10.....	200	16	32	
11.....	200	9	18	Group I. Auto machines. Wages part of machine rate.
12.....	200	9	18	
13.....	200	9	18	
14.....	200	9	18	
15.....	200	9	18	
16.....	200	9	18	
17.....	200	15	30	Group 2. Auto machines. Wages part of machine rate.
18.....	200	15	30	
19.....	200	15	30	
20.....	200	15	30	
21.....	200	15	30	
22.....	200	15	30	
<b>TOTALS</b>	<b>4,400</b>		<b>\$576.00</b>	

The shop and cost accounts are presented, first, during a period in which the shops were full of work, and secondly, some months later when trade was very quiet. The same job is given under the two conditions, and is also shown separately in the second period, as an improvement in the method of manufacture was made at this time.

MASS PRODUCTION AND THE MACHINE RATE 93

COST STATEMENT OF JOB (JANUARY).

10	Hours	machine	No. 9	@	4	cents	per	hour	.....	\$0.40
6	"	"	"	8	@	34	"	"	.....	2.04
12	"	"	"	17	@	15	"	"	.....	1.80
3	"	"	"	3	@	23	"	"	.....	.69
Add.									Total machine rates,	\$4.93
Supplementary rate @ 2.27 cents per hour on 31 hours,									.....	.70
									Total shop charges,	\$5.63
10	Hours'	wages	@	31	cents	per	hour	.....	\$3.10	
6	"	"	@	10	"	"	"	.....	.60	
3	"	"	@	14	"	"	"	.....	.42	
									Total wages,	4.12
Total No. 2 or works cost of job,									.....	\$9.75

It will be noticed that in this month all the machines made full time; consequently the supplementary rate was very low, viz.,  $2\frac{1}{4}$  cents per hour. The contrast between the average hourly-burden plan figure, viz., 15 cents per hour, and the new method, is very well seen by a glance at the Table A of machines. We have here machines which are rated as high as 34 cents per hour, whilst others are as low as 4 cents, this latter machine being a watchmaker's lathe, operated by a highly paid man. These differences in the incidence of shop charges being based on real figures, it is obvious that the new method offers an important advantage in differentiating such different charges as 4 and 34 cents per hour, in place of averaging them all round, as the hourly-burden plan does, on a basis of 15 cents.

In the cost statement it will be noticed that only three items of wages figure, although there are four machines concerned. This is because machine No. 17 is one of the automatic machines, and the cost of operating this is charged to the machine rate, as previously explained in this article. When we come to contrast this job-cost statement with that for the same job in slack times, the further advantages of the method will be seen.

The month of November was a very bad one; the factory was working barely half time. Yet, naturally, the debits against the shop were not reduced in anything like the same proportion.

SHOP-CHARGES ACCOUNT (NOVEMBER).

<i>Debit.</i>		<i>Credit.</i>	
To Interest on machine.....	\$53.00	By Machine earnings.....	\$292.53
" Depreciation on machine.....	53.00	As Table A	
" Power.....	62.00	" Supplementary rate.....	305.47
" Wages on 'auto machines.....	55.00	\$305.47	
(1 operator and overlooker)		Hrs. 2,187 = 14 cts. per hour.	
" Process sundries (oil, etc.).....	25.00		
" Debit for floor burden.....	250.00		
" Supervision.....	100.00		
	<hr/> \$598.00		<hr/> \$598.00

Total hours made as Table A = 2,187. Supplementary rate this month = 14 cents per hour. Average hourly burden on hourly-burden plan would be  $\frac{598}{2,187} = 27.3$  cents per hour.

MASS PRODUCTION AND THE MACHINE RATE 95

TABLE A.—SHOWING MACHINE TIME MADE AND MACHINE EARNINGS IN NOVEMBER.

No. of Machine.	Total Hours Worked in Month.	(New) Machine Rate Per Hour.	Earnings—i. e. Amt. debited to Jobs per Machine Rate.	Remarks.
1.....	130	4 cents.	\$5.20	
2.....	125	7 cents.	8.75	
3.....	86	23 cents.	19.78	
4.....	140	25 cents.	35.00	
5.....	200	12 cents.	24.00	
6.....	200	10 cents.	20.00	
7.....	200	9 cents.	18.00	
8.....	90	34 cents.	30.60	
9.....	200	4 cents.	8.00	
10.....	80	16 cents.	12.80	
11.....	.....	.....	.....	} This group was idle and operator stopped.
12.....	.....	.....	.....	
13.....	.....	.....	.....	
14.....	.....	.....	.....	
15.....	.....	.....	.....	
16.....	.....	.....	.....	
17.....	140	15 cents.	21.00	
18.....	80	15 cents.	12.00	
19.....	96	15 cents.	14.40	
20.....	140	15 cents.	21.00	
21.....	140	15 cents.	21.00	
22.....	140	15 cents.	21.00	
<b>Totals</b>	<b>2187</b>		<b>\$292.53</b>	

COST STATEMENT OF SAME JOB (NOVEMBER).

31 hours' machine time (details as before).....	\$4.93
Supplementary rate, 31 hours at 14 cents.....	4.34
<b>TOTAL SHOP CHARGES.....</b>	<b>\$9.27</b>
19 hours' wages (details as before).....	4.12
<b>TOTAL No. 2 OR WORKS COST OF JOB.....</b>	<b>\$13.39</b>

There was in consequence a sharp rise in the ratio of charges to work.

The effect of this can be seen in the cost statement of the job. The works cost of this has gone up from \$9.75 to \$13.39, although precisely the same machine time and the same amount of wages was expended in the one period as in the other. A glance at the statement tells us, however, that the increased cost is wholly comprised in the one item of supplementary rate, and was not due, therefore to removable causes as far as this job is concerned.

Now on any average distribution plan, whether by percentage on wages or by averaged hourly burden, this information would be lacking. We should see merely that the debit for expenses against that particular job, and its works cost, was higher; but *why* this was so, whether due to variation in process or wholly to increase in the ratio of charges, would not be ascertainable without considerable investigation and analysis. Here, on the contrary, it is seen at once that the debit for machine time—viz., \$4.93—is the same as usual, thus allowing us to compare the debits due to variation of process at different periods, quite irrespective of whether the shop is busy or slack.

Apart from the greater precision and accuracy of the method, this disentanglement of the charges for work done from the charges due to slackness is a very considerable gain. It is, in fact, a step nearer the true representation in the accounts of

what has actually happened in the shops. By bringing out all natural differences to the full instead of averaging them all down, we obtain a stronger grasp of the situation.

In the following statement the cost of this job for November has come out at \$11.35 instead of \$13.39. The difference is due to an improvement in method of working. The important point is that neither the wages nor the hours taken have varied; therefore on any averaging system, whether on wages or by hourly burden, this improvement would be absolutely lost sight of, inasmuch as neither of the factors on which they rest has happened to vary.

COST STATEMENT OF JOB.

PUT THROUGH IN NOVEMBER, BUT ON AN IMPROVED METHOD.

10 hours No. 9 @ 4 cents per hour.....	\$0.40
*6 hours No. 2 @ 7 cents per hour.....	.42
12 hours No. 17 @ 15 cents per hour.....	1.80
*3 hours No. 7 @ 9 cents per hour.....	.27

Total machine rate, \$2.89

Add supplementary rate

31 hours @ 14 cents per hour.....	4.34
-----------------------------------	------

Total shop charges, \$7.23

10 hours' wages @ 31 cents.....	\$3.10
6 hours' wages @ 10 cents.....	.60
3 hours' wages @ 14 cents.....	.42
Total wages (same as before)	\$4.12

Total No. 2 or works cost, \$11.35

\* Altered process. Compare with former statements.

But a glance at the job in the form presented here is sufficient to show what has happened. Wages are the same, supplementary rate is the same, but the debit for machine rate is less. This leads us at once to the nature of the change which has resulted in an economy. It is that in two cases, a less heavily rated class of machine has been substituted for those in use before. Machines at 7 and 9 cents per hour have superseded machines at 34 and 23 cents per hour.

On no method but a machine-rate method can differences of this important class be made visible, and no machine-rate method is in itself complete or advisable, unless accompanied by the device of the supplementary rate to absorb and deal with the idle time. But with these combined, the resulting method is not only more accurate, but fulfils functions which are entirely missed in other methods.

In the next chapter, (which will conclude this discussion,) the question of general establishment charges, i. e., those due to the selling organization, will be dealt with, and some remarks will be offered on the proper uses and digestion of costs and establishment-charge accounts.

## CHAPTER VI.

### APPORTIONMENT OF OFFICE AND SELLING EXPENSE.

**I**N the preceding chapters the question of shop or works charges has alone been considered. It has been shown that an improvement on the present practice of averaging these charges is possible, and that there is no reason why each item of product shall not be as definitely connected with its proper portion of such charges as with the corresponding portion of wages spent directly on it.

It was explained in the first chapter that shop charges do not by any means exhaust the whole of the expense account. In addition to the charges actually incurred in production, there is a large section of expenses incurred in advertising, warehousing, packing, transporting, and conducting the commercial processes incident to selling the finished product. These expenses should not on any account be mingled with those due to production.

In the case of a concern of which the works is in the country and the commercial office in the metropolis, this division of charges takes place naturally and almost automatically. We need not stop to



discuss here the few minor points in which the division is indistinct; it will be sufficient to notice that there is for the most part a broad and strongly marked natural distinction between the two classes.

It has already been shown that the shop charges have a real relation to the work, and that all we have to do in their case is not to cover up or average away such real relation, but rather to seek to develop it. We have now to consider whether there is any similar real connection between the value of finished product and the general establishment charges.

It may be stated at the outset that there is no such connection. The cost of marketing an article has no ascertainable relation to the cost of making it. The immediate inference from this is that in whatever way we finally decide to distribute general establishment charges, a more or less arbitrary basis of incidence must be made use of. But this does not imply that there is no utility in discussing this basis very fully. On the contrary, the cost of selling requires as careful elaboration as the cost of producing, inasmuch as commercial ability is more rare and subtle than technical ability, and articles which are being produced cheaply enough may fail to show a profit owing to waste in the methods of finding a market for them.

The modern tendency to eliminate the middleman and sell direct from the factory to the con-

sumer makes the question of general establishment charges one of growing importance. In some trades, as for instance the textile trades, where the product is sold to merchants mostly before manufacture, orders being taken in open market, ("on change"), the general charges bear a very small ratio to the finished article. But in proportion as the commercial side is developed and stocks are held, together with a great extension of advertising, travelers, and agents, these charges begin to loom large and may represent more than half of the ultimate sale price. The importance of knowing in such case precisely what it costs to sell, as well as what it costs to make, cannot be denied.

The theory of general establishment charges may be briefly stated as follows:—having produced certain articles which are found to have cost  $N.$ , we have to spread over such cost an additional amount.  $M.$ , which we find represents the cost of selling the value  $N.$  at a profit. Now the cost of selling has not, as already remarked, any proportionate relation to cost of making at all. And the real difficulty of basing the incidence of general charges on shop cost is that these charges do not get higher as works cost gets higher in the majority of cases, for the increase in cost of production is usually at the expense of profit. It is not often that the price obtained for an article is otherwise than ruled by the state of the market. And certainly accidental

increases in production cost are at the expense of profit only in almost every case. If, therefore, we base the incidence of general charges as a mere percentage on wages, or on works cost, we are doing something which is very easy and simple, but which is almost sure to be very misleading in cases where there are more than one or two different classes of articles concerned. At the same time, it is evident that *some* basis of value must be taken before we can distribute at all. It is not practicable to isolate the expenditure on advertising, traveling, and so forth so as to debit each piece with the amount incurred on the selling of it; we have therefore to compromise the matter, and compensate the faults of the basis by a classification method which will enable us to discriminate between various classes of products. Even then there is a choice between three bases of value on which the general charge may be distributed.

General charges may be distributed: 1, on wages cost only; 2, on works cost; 3, on an hourly basis, according to the number of hours consumed in the production.

For ordinary manufacturing purposes, it is probable that the last method has the balance of advantages in its favor. The proposal will be understood if it is stated that the basis of distribution is an hourly-burden method. Also the entirely arbitrary nature of the basis will be strongly demonstrated.

There is obviously no connection between selling expenses and the number of hours occupied in making. Neither is there any connection between wages, or prime cost, and the cost of selling. Many persons, however, are under the impression that there is. The reduction of the basis to hours instead of dollars or shillings will help to disperse this impression, which is of course without any foundation whatever.

Having decided on the basis for distribution, there is next the question of how to compensate for its arbitrary character. Its only merit is that it provides a common basis for distributing over classes of articles which may be very varied indeed, and it has, of course, a direct ratio with the activity of the shops during any period of which it is required to distribute the general charges. On the other hand, in cases where a factoring business in addition to a manufacturing business is done, or where the product includes heavy *purchases* of material, additional arrangements are necessary to deal with these variations.

If, now, we regard a given case in which there are, for example, three distinct products manufactured by the firm, one of which is a small item made in large quantities, and almost a "staple"—that is, a readily marketable product depending on the condition of the market for its sale and price rather than on any special efforts of the commercial

arm to push it—the others being respectively an ordinary engineering device such as a lathe or pump, fairly well standardized and sold from catalogue, and finally a special class of thing, such as a crane, which has to be treated individually, involving a good deal of staff time for drawings, measurements, consultations, visits, etc., in each case—if we consider a case like this, it will be evident that to treat each of these classes alike in the proportion of general charges debited to it will be to do a serious injustice to the more easily sold things, to the benefit of the less easily sold. And when the question of what class of business it pays best to exploit is under consideration, this becomes a vital matter indeed.

It may perhaps be suggested that no system of establishment charges is required to inform a practical man on this point. And in the strongly contrasted cases which have been purposely selected, this may perhaps be so. But in proportion as the difference between classes becomes less, the problem becomes obscure. A shrewd guess may be made, and in the absence of actual knowledge must be, as to what is the most profitable class of several. The whole tendency of modern organization is, however, to do away with the necessity for guessing at all.

It is necessary, notwithstanding, to beware of relying on figures unless the conditions under

which they are true are well known. A misleading method is, of course, much worse than none at all. It is for this reason that the essential falsity of averaging general charges all round should be clearly recognized, just as it has been shown that the method is false for shop charges. And when, as is usually done, *both* these classes of charge are lumped together and averaged over the work without any differentiation at all, it is difficult to avoid the conclusion that the practice is a dangerous one.

This caution is necessary at the point we have reached in the discussion of methods of dealing with general establishment charges. It is not pretended that the system here described is as final and accurate as the method of dealing with shop charges. These latter are real, and their connection with each item of work is also real. But as has been frankly admitted at the outset, the connection of general charges with work is not real, but entirely arbitrary and conventional, from the very nature of the elements concerned. All we can hope to do is to approximate the figures to the actual facts, by further artificial means. Therefore the proportion of general establishment charges debited against any particular order must always be regarded with due reservation.

The most practical method of correcting the errors introduced by the artificiality of the basis of distribution, is by means of classification whereby the

incidence which would otherwise fall equally on each kind of work is made to fall unequally. A number of classes are created, the incidence in the first of which is, say, 100, the incidence in the second being 120, that in the third and fourth perhaps 150 and 170 respectively, and so on for as many classes as may be found necessary. Leaving aside for the moment the considerations which determine in what particular class any given article shall stand, it is evident that if we have a thousand dollars to distribute, the first class will get off lighter and the last class will be more heavily debited than on an ordinary averaging plan. Therefore if any reasonable means of classifying articles can be devised which shall correspond as closely as possible to the differences in their commercial treatment, the arbitrary character of the original basis will be to a large extent minimized. There still, however, remains the objection which must never be lost sight of when consulting the figures, that an undue rise in production-cost will lead to a disproportionate absorption of general charges, in whatever class the article may happen to be.

The process of determining the classification is, unfortunately, somewhat difficult, or at least demands a good deal of thought and care at the outset. Space will not permit of its full treatment here; only the principle followed can be detailed. Every item of general charges must be tabulated.

The average annual cost of advertising, traveling, drawings, patterns, catalogues, correspondence department, cashiers and book-keeping, management, and all similar expenditure must be got out and arranged in columns. These are the items of which the incidence has to be settled. Now against these has to be placed each of the different classes of articles manufactured, and each one of these has to be carefully reviewed with relation to each of the items of expense.

Thus, for instance, advertising. Analysis of the advertising expenditure may show that one article has practically no concern with advertising. Of this class an obvious example is repairs to the firm's own products. Other articles, on the contrary, may involve special advertising, and should of course be debited with the whole of such special expense. Catalogues are open to similar analysis. Such items, again, as are standard articles supplied either from stock or from standard parts, involve much less of the expenditure due to correspondence than do special jobs. Repairs, on the other hand, although escaping the advertising debit, should be visited heavily on the correspondence and book-keeping sections, since these small jobs cause as much work to these departments as do standard orders of fifty or a hundred times their value. From this brief description it will be seen that the general establishment charges are capable of a very



detailed analysis. It is true that the element of judgment is very strongly involved in this analysis, but there is a difference between judgment and mere guesswork. There is no reason why a very close approximation to facts should not be made at this stage if the work is carried out by a competent person, who has access to all the data necessary for decision.

The method of working up the analyzed details into percentage figures on which the distribution of general charges is actually made will be better understood from an example. In the following table only three classes of articles have been taken, and only three out of the many items of establishment charges. The principle will be none the less clear.

TABLE SHOWING METHOD OF APPORTIONING DIFFERENT ITEMS OF GENERAL ESTABLISHMENT CHARGES ON DIFFERENT CLASSES OF WORK.

Class.	Output.	Advertis- ing Exp.	Catalog Exp.	Correspond- ence Dep. Exp.	Totals.	Percentage of Incidence.
Standard lathes ..	\$100,000	\$7,000	\$4,800	\$1,660	\$13,460	13½
Special cranes....	20,000	3,000	200	1,340	4,540	22½
Repairs.....	20,000			2,000	2,000	10
Totals.....	\$140,000	\$10,000	\$5,000	\$5,000	\$20,000	*

\* Average percentage would be 14½ per cent.

The figures in the expense columns of the above table are obtained by carefully considering the items with reference to the output. Thus, on examining

the advertising account, it was found that \$3,000 was spent in advertising special cranes, leaving the remainder of that expense to fall upon the standard lathes. Catalogues, again, not containing more than a mention of the cranes, were adjudged to be borne almost entirely by the lathes. On the other hand, when the work and expenditure of the correspondence department was reviewed, it seemed just to apportion the expense much more equally between the three classes. The result of these several apportionments having been summarized for each class and the ratio established between them and the volume of business done, it is found that while as might have been expected the standard lathes which form the great bulk of the output absorb very nearly the average amount of incidence, viz.,  $13\frac{1}{2}$  per cent instead of  $14\frac{1}{4}$  per cent, the other classes, viz., cranes and repairs, differ considerably from the average, the former taking nearly 23 per cent and the latter 10 per cent.

In distributing general charges each month, effect is given to these percentages. The total expenditure being found, it is not averaged indiscriminately over the whole output for that month, but in such a manner that when all is distributed the proportion between the various classes is maintained. This is done by a very simple calculation, not demanding in its practical working anything more than common arithmetic. The result obtained is decidedly in-

structive. Assuming that the classification has been carefully made, the relative profitableness of any class of work can be ascertained. And if at any time it is found necessary to revise the percentage for any class, this can be done without disturbing other classes. For, as will be seen from an examination of the table above, if the percentage of any class is slightly reduced, it fails to absorb so large a proportion of the expenses, which consequently fall more heavily on all the other classes.

It must not be overlooked that a fundamental principle of the distribution is that the debit for general expenses shall be exactly cleared by the total of the allocation to classes. The percentages here express merely the *relations between the classes*, and not any definite percentage on values. If one class takes 10 per cent, another 15 per cent, and a third 20 per cent, this merely means that the general expenses, whatever they are, are distributed on the basis of that *relative* difference between the shares taken by each class. It does *not* mean that Class 1 gets 10 per cent only on its value, but that if Class 1 gets a certain burden, Class 2 has one-and-a-half times and Class 3 twice as heavy a burden in proportion to hours or value. That is, if Class 1 has a burden of 4 cents an hour, Class 2 will have 6 cents and Class 3 will have 8 cents. The actual burden will, of course, depend on the amount to be distributed.

If then we find that any particular class is absorbing expenses to such a tune that there is no profit left when prime cost, shop charges, and general charges have all been debited, a prima-facie case is made out for supposing that this class is not remunerative at the prices obtained. Before we can say that this is actually so, the basis of classification must be carefully examined to see if it has been assessed with undue severity on that article. This will perhaps involve some trouble, but it is eminently a case in which it will pay to spend trouble.

Between the shop charges and the general charges there is, then, this difference: while the first, if properly arranged in the first place, are subject to no appeal, as they are real figures and do show exactly what has taken place, the general charges may be looked on as rather in the nature of a danger signal which gives warning of a probable pitfall, but which may, if careful enquiry approves, be put on one side and its readings modified. It would be better, of course, if the figures pertaining to general charges were as real and reliable as those of the shop charges. But there seems to be no possible hope of their being made so. There is no visible and tangible result connected with concrete things in the case of general charges. Nothing is produced. Expenditure may, in fact, lead to no result at all—nay, does often lead to pure loss of money and

time. It is this vagueness of the general charges that forbids our regarding them as bed-rocks on which we can base deductions without further enquiry. But there is no excuse for not making them as useful as possible, reading them as indications if not as facts.

Enough has, perhaps, been said about the character of these general charges to emphasize the remarks which have been made several times in the course of these articles as to the infinite importance of separating them from the shop charges. Mr. Slater Lewis's theory on this point is very clear and distinct, and should be studied by every manufacturer who cares for accuracy and clearness in place of confusion and mixed results in his accounts. It is not too much to say that any system of accounts which lumps both classes of charge together and averages them all round is entirely worthless. Far from being an improvement on a simple system of prime cost, it is probable that it may easily, by inducing a false security, be positively dangerous and worse than no system at all.

The conclusion of this demonstration has now been reached. An attempt has been made to develop in an orderly manner the method of dealing in an improved way with the very difficult subject of establishment charges. Endeavor has been made to show that present methods are not satisfactory in that they seek to mingle elements which have

nothing in common, and which are, on the contrary, naturally distinct. In particular it has been shown that the old idea of the machine rate was based upon a theory essentially correct, but incomplete. It fulfilled functions which were seen to be desirable, and which have been altogether neglected in the more modern methods that have succeeded.

The fault of the machine rate, or perhaps we may say its misfortune, was that it was born and came to maturity in the archaic ages of cost accounting, and that it therefore sinned against the most serious canons of modern theory and practice, viz., that whatever else is done, *every dollar of charges must be burdened onto some item of work*. The machine rate failed because in the first place it dealt with only one or two items of expense, usually interest and depreciation alone, and in the second because in the case of idle time it simply lost sight of the charges which were nevertheless still there.

The main feature of the system proposed, as will have been gathered by those who have followed these chapters, is that not only do the new machine rates deal with nearly all items of shop charges on a natural basis, but by the device of the *supplementary rate* all the lost time is picked up and distributed separately, thereby leaving the significance of the machine-rate figures unalloyed by the accidental conditions of the shop at any time. Further it has been shown that the supplementary rate forms in itself a useful barometer of conditions.

Although necessities of space have prevented a full discussion of the complex subject of general charges, enough has perhaps been said to show that the principle of averaging is not the best possible. It has been demonstrated that a certain amount of connection can be developed, not between general charges and *individual articles*, but between such charges and *classes of products*. And while the results are not as precise and indisputable as in the case of shop charges, there is still a decided gain by effecting this connection as far as it can be done, the results being looked on as in the nature of a guide or warning rather than as positive and definite information.

The whole tendency of what has been said is to the effect that by suitable arrangements on the lines proposed, manufacturers should be in a position to get much further into touch with the details of their work than they have any chance of doing on present methods.

A few final observations may be offered on the subject of works accounting generally. Modern methods have taken their rise in the growing complexity of modern industry. They, like the industry itself, tend to become more complicated in proportion as the numbers of their factors increase. The snare of the "simple system" must therefore be avoided. One cannot calculate the weight of the earth or the distance of Uranus by means of

common arithmetic. Nor can anyone represent the thousand-and-one interlocked factors of a modern factory by means of a double-entry ledger and an office boy. And just as the whole science of navigation hinges on higher mathematics, so the management of a considerable business turns upon intricate principles which are the horror of the rule-of-thumb man and the sheet anchor of the progressive man of business. Now one can traverse the Atlantic in an open boat and without the Nautical Almanac, but it is done more quickly and more surely in the Mauretania.

No system, however good, will give immediate results. It must be established, and must have run smoothly for months and even years before the full advantages are realized. For all progress is made by comparing what was done today with what was done some time ago, and this can be done to any purpose only when the basis of comparison is similar. From the nature of the case, no spasmodic efforts at the introduction of new methods are of the smallest use. To be of final and real commercial and technical value, records must be continuous and extend over various fluctuating periods of trade.

It will seem superfluous to many who read these pages to insist on the necessity of connecting the establishment charges as closely with costs as it can possibly be done, yet the truth is that comparatively



few manufacturers are awake to this necessity. They do not realize that in all industries it is the narrowing of margins of profit, too often to the vanishing point, that has brought this question to the front. Fifty years ago, though there was a need (as evidenced by the tentative introduction of machine rates), there was not a pressing and imperative necessity for the manufacturer to look so closely and minutely into what he was doing. And only the "coming men" feel that necessity now. The older concerns will probably never come to that point, for they will have become exhausted in the effort to find out what was wrong with them.





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